THE STANDARD CYCLOPEDIA
OF MODERN AGRICULTURE
AND RURAL ECONOMY

THE STANDARD CYCLOPEDIA OF MODERN AGRICULTURE AND RURAL ECONOMY

BY THE MOST DISTINGUISHED
AUTHORITIES AND SPECIALISTS
UNDER THE EDITORSHIP OF

PROFESSOR R. PATRICK WRIGHT

F.H.A.S. F.R.S.E. PRINCIPAL OF THE WEST OF SCOTLAND
AGRICULTURAL COLLEGE GLASGOW

VOLUME IX

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THE GRESHAM PUBLISHING COMPANY
34 AND 35 SOUTHAMPTON STREET STRAND LONDON

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The classic series of articles on insects by the late John Curtis have been embodied in the work, revised by Professor F. V. Theobald and Mr. Cecil Warburton, M.A., and bear the initials of J. C. and F. V. T. or C. W.

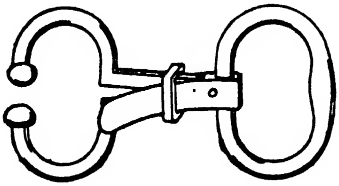
In like manner the great botanical articles of the late Professor John Lindley, which, like Curtis's articles above-mentioned, were contributed to Morton's *Cyclopedia of Agriculture*, have, under Professor A. N. M'Alpine's revision, been embodied over the initials J. L. and A. N. M'A.

THE STANDARD CYCLOPEDIA OF MODERN AGRICULTURE

Meteorology, the science or branch of knowledge that treats of atmospheric phenomena relating to weather and climate. The phenomena with which it deals and the instruments used in their observation are mainly these, viz.: temperature (thermometer), humidity (hygrometer), atmospheric pressure (barometer), wind (anemometer), rainfall (rain-gauge), and clouds. These phenomena are all referable to the action of the sun, and accordingly present variations depending upon locality (including the infinitely varied physical features of different places), the diurnal revolution of the earth upon its axis, and the annual revolution of the earth round the sun. It is the business of meteorology to examine the laws which regulate these variations. It pursues its enquiries in two directions: (1) with reference to the variations observed at different times in the same locality with the view of obtaining average results as to its climate—climatology; and (2) with reference to the variations observed in different localities at the same time with the view of arriving at the laws which regulate the changes in the weather—weather study. In the prosecution of this study observations are taken at the same hour of Greenwich time at a number of stations situated over a large extent of the earth's surface. These observations include readings of barometer, thermometer, hygrometer, rain-gauge, anemometer, &c., with non-instrumental observation of clouds. The results which indicate the phenomena existing at that hour at the several stations are tabulated, or registered, formed into weather charts, &c. These charts are made by putting down on a map readings taken at the same moment over a large tract of country, and joining by lines the points where the readings agree. Since the general use of the electric telegraph this branch has assumed great practical importance. By its means observations made at many distant places may be immediately communicated to one centre, and men of science are thus enabled to forecast with considerable accuracy the weather which may be expected in certain districts. Such forecasts can be made with great accuracy in tropical and sub-tropical countries where the atmospheric conditions are very constant, and variations from the average are consequently easily observed. They are attended with much more difficulty in temperate countries. In the British Isles they are exceptionally difficult, owing to the fact that on the side from which nearly all weather changes come, namely, the west, the existence of the Atlantic Ocean renders telegraphic warning of changes of weather impossible. The fact that a storm is travelling eastward may be telegraphed from America, but there is always a chance of its being dissipated or deflected long before it reaches the coasts of Europe. It having been observed, however, that a storm is always preceded by a fall of the barometer, the tendency to fall is observed some time before the minimum depression occurs; the notice of this tendency, together with observations of the wind and motions of cirrus clouds, enables storm warnings to be sent from observatories to the Meteorological Office established by Government in London, whence they are telegraphed to the various parts of the United Kingdom. The farther eastward we travel in Europe the easier does the forecasting of the weather become. In the United States, where the majority of storms rise in the district to the west of the Mississippi, and are thus capable of easy observation, great accuracy has been attained. In Great Britain, the United States, and most civilized countries, systems of weather forecasting have now been established since about the year 1860, the name of Admiral Fitzroy being associated with the early days of the system in England. The United Kingdom is now divided into eleven districts, and a forecast for each of these is issued twice a day—thus rendering some service to agriculture. Weather disturbances are generally cyclonic or anticyclonic in character. See WEATHER, INFLUENCE OF, ON CROPS.

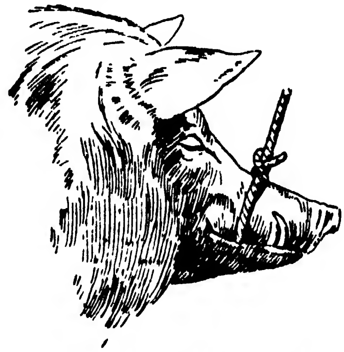
Methods of Control and Restraint.—The animal doctor is at every point confronted with the difficulty of restraining or controlling his patient, whether for the administration of medicines (see MEDICINES, ADMINISTRATION OF), or the performance of major or minor operations. At one time he is required to medicate or operate upon an unbroken colt (see article BREAKING) or unhandled bull; at others a savage sow, timid sheep, or morose dog; or his subject may be a horse or dog so well disciplined as to submit to almost anything when controlled only by the voice. A broken horse may be sufficiently restrained by holding up a front or hind leg, or by the application of the ordinary twitch; or it may be necessary to cast him by ropes or hobbles, as shown in the article CASTING A HORSE. By

means of stirrup strap or Rarey's leg strap, with kneecaps for protection, and a rope, exponents of the art of control have demonstrated their entire authority over wayward beasts. Rarey, Hayes, Sample, Galvayne, and others have been able to impart the art to some of their pupils; but the safer methods of casting, as illustrated in the last-mentioned article, are more likely to give satisfaction where a scratch team has to be relied on. Cattle may have to be noosed by the horns; and when this is done they should be secured to a beam overhead, and not drawn up to a wall, lest a horn may be broken. The bull-holder or nose-clamp affords the best hold on a bullock, but he may have to be noosed in order to apply the instrument. Cattle not being accustomed to having their legs held up, cannot be controlled in this way; but for dressing diseased feet, a cord and overhead pulley may



Bull-holder or Nose-clamp

be used if the beast is confined in a narrow stall, and a couple or more men push him against his side at the same time. A cow's preference for her own stall makes her more easily handled there than if removed. Pressure of the thumb and fingers over the withers has a more or less controlling influence over these animals, and may suffice when a hypodermic injection is to be given, as in tuberculin testing. For minor operations in the region of the udder, cow-ties may be used, these generally consisting of horse hair plaited and looped at the ends, and passed round the two hind pasterns or just above the fetlocks. Soft rope will do; but a beast unaccustomed to this method of restraint will often fight against it, and a little time should be allowed for the animal to discover its helplessness before attempting the operation. Tying head and tail together, or the mere holding up or down of the tail, will restrain some individuals, while others must be thrown to the ground for any but the most trifling operations. Hobbles, or loops of rope around each pastern and a running rope through all of them, on the same principle as horses are cast (see CASTING), will prove successful; or looping the hind limbs only and passing the running rope between the front legs, or noosing one front and hind leg of the same side, will succeed, if the head is suddenly turned to the opposite side. Unless one is dexterous enough to take the bullock by surprise, it is better to hobble all four legs and rely on force chiefly, although most animals contribute to their own fall, and the passive resisters prove the more difficult to throw. If cattle must be cast, a deep bed of straw should be employed. Some of the most expert spayers we have known, lash their victim to a gate or ox fence. Youngsters up to a year or more may be controlled in the way described under CASTRATION. Sheep are so easily controlled that it is scarcely necessary to refer to turning; but it may not be known to those who have not castrated adults how easy it is, if a man sits astride of a hog form, to hold a powerful animal, whose weight is sustained by the form, the animal's back being to the man, and the latter grasping a front and hind foot in each of his hands. Pregnant ewes should not be so controlled, but gently restrained

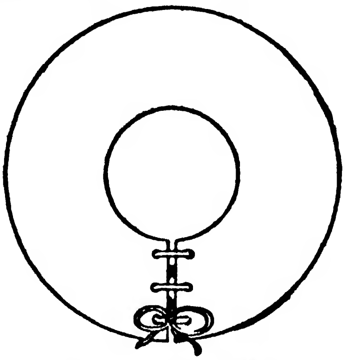


Noose for Pig, attached to upper jaw

upon their sides, if footrot or other troubles need to be attended to. Pigs at all ages are troublesome creatures to hold, and easily choked. A noose can with patience be got into the mouth, and should be pulled up over the face; not attached to the under jaw, which in the Tamworths and long-faced animals may receive serious injury during the animal's passionate efforts to break away. When medicines have to be given by force, there is no better 'bottle' than an old boot with the toe cut off, the pig finding satisfaction in biting it, and more or less unconsciously swallowing the liquids poured in at the top. Young animals, of whatever species, that have never been conquered by the halter or the noose, should not be tied to a fixed point, but the cord should be passed round a post or rail and in charge of a man, who will slack out if the prisoner seems in danger of injuring himself. Dogs are restrained by many means, but an injured or savage one may have to be noosed round the neck; or if he have on a collar a hooked stick may be got under it, and a turn of the wrist will soon ensure a victory, after which a clove hitch will render the operator safe from his teeth, but not his nails, which can inflict considerable injury—a fact that is only remembered by canine specialists, who most fear dogs' nails and cats' bites, con-

Clove Hitch for Dog

rary to the generally accepted views as to the risks entailed in handling these animals. Dogs, more than cats, are disposed to tear off bandages or other appliances, and may be restrained by an Elizabethan frill or collar cut out of floor-cloth or stiff cardboard and attached to an ordinary strap collar. This appliance, if sufficiently wide, makes it difficult to lick any part of the body, and prevents striking the base of an itching ear with the hind foot. If it is desired to protect the trunk from the animal's interference, a corset may be made, with cane or whalebone ribs running from the elbow to



Dog Collar (Elizabethan Frill)

the stifle joint; but special arrangement is necessary for male dogs to enable them to urinate. Cats are best controlled by being rolled up in a soft blanket, into which they can fasten their talons and help to secure themselves; the part to be treated may then be exposed, and the legs held by an assistant. With only the head exposed, a cat can be held by the ears and scruff of the neck while a fish bone is taken out of the mouth; or if castration is the object, the hind legs are pulled out of the blanket, while the cat is held between the knees of the operator. The most convenient and merciful means of restraint for the performance of operations of any magnitude are to be found in the employment of anæsthetics, either local or general. See also EYE, DISEASES OF. [H. L.]

Metric System.—The measurement of any quantity is the comparison of the quantity with a standard quantity of the same kind which is called the unit. Thus the measurement of the length of a given object is made by comparing the lengths of the object and a footrule, and the measurement of a weight by comparing it with the weight of a standard piece of metal, a pound weight, ton weight, &c. The footrule thus gives a unit for length measurement, the pound weight a unit for weight measurement. Lengths are quantities which have to be measured very frequently, and vary in magnitude between those which we characterize as minute and immense. A unit which would be useful in estimating a minute distance would be useless in estimating an immense one. Thus the diameter of a hair might be most conveniently expressed in hundredths of an inch, but it would be most inconvenient to express the diameter of a steamship's funnel in those units. The unit of weight which is used in apportioning a dose of a powerful drug would be too small for expressing the weight of a bag of corn. Thus subsidiary units have to be introduced which are multiples or parts of the standard unit. The multiples are used for estimating quantities which are too large to be expressed by a convenient number in terms of the standard unit, the parts for those which are too small. Thus the standard unit of length is the *yard*, which is the distance between two hair-lines marked on gold studs which are inserted in a bronze bar. The standard yard is deposited in the Board of Trade offices, and elaborate apparatus has been constructed for the manufacture of extremely accurate copies of it. The subsidiary units of length are the pole, furlong, mile, for large, and the foot and inch for small, estimations. Similarly, the standard weight-unit is the *pound*, and subsidiary units are the hundredweight, ton, ounce, dram. Now common sense indicates that the subsidiary units should be multiples or quotients of the standard units by such numbers as will make the reduction from the one to the other as simple an arithmetical process as possible; but the present British system of units not only does not fulfil, but seems designed in defiance of this rational requirement. To reduce our measures we have to multiply and divide by such cumbrous numbers as 12, 16, 27, 144, 1728, $5\frac{1}{2}$, $30\frac{1}{4}$. Let anyone try to calculate the value, at £1 per cubic foot, of the contents of a box whose edges are, say, 3 ft 6 in., 4 ft. 10 in., 2 ft. 8 in., and he will realize the arithmetical drudgery entailed by an unsuitable choice of subsidiary units. Multiplication by 10, 100, 1000, &c., is performed by merely transposing the decimal point, and hence in a common-sense system of units the subsidiary units should be multiples or quotients of the standard unit by 10, 100, 1000, &c. Such is the case in the *metric system*, which is in use on the Continent. To denote that a unit is 10, 100, 1000 times the standard unit, the prefixes (derived from the corresponding Greek numerals) deca-, hekto-, kilo- are used in conjunction with the name of the standard unit; and to denote that a unit is $\frac{1}{10}$, $\frac{1}{100}$, $\frac{1}{1000}$ of the standard unit, deci-, centi-, milli-, which are derived from the Latin numerals, are employed. Thus the standard unit of length is the *metre*, which is about 39·37 in., and we have—

1 millimetre	=	$\frac{1}{1000}$ of a metre.
1 centimetre	=	$\frac{1}{100}$ "
1 decimetre	=	$\frac{1}{10}$ "
1 decametre	=	10 metres.
1 hektometre	=	100 "
1 kilometre	=	1000 "

(The decametre and hektometre are not in general use.) Similarly, the standard unit of weight is the *gramme*, and the subsidiary units in common use are the *kilogramme* (1000 grammes = 2·2 lb.), and for scientific purposes, the *milligramme* ($\frac{1}{1000}$ gramme). The *tonneau* (corresponding to our ton) is also used, and is equivalent to 1000 kilogrammes.

The standard units of surface and capacity are the square metre and cubic metre respectively; but the units generally used are the *are* (100 square metres) and *hectare* (100 ares) for area measurement, and the *litre* (or cubic decimetre) and multiples of the litre for volume measurement.

The monetary systems in use on the Continent are also decimal. Thus in France the *franc* is divided into *centimes* (1 centime = $\frac{1}{100}$ franc), and coins of the value of 10, 20, 50 centimes are employed for small sums. For large sums, coins of the value of 10, 20, 50, 100 francs are used.

The decimal system has also been extended to the graduation of the thermometer. The scale used is the *Centigrade scale*, and in it freezing-point of water is taken as zero, and the temperature of boiling water corresponds to 100 degrees.

Under a decimal system, an example such as we have stated might read: Find the value at 20 francs per litre of the contents of a box whose edges are 3·6, 4·1, 2·8 metres. The arithmetical solution is—

$$\begin{aligned}\text{Content} &= 3{\cdot}6 \times 4{\cdot}1 \times 2{\cdot}8 \text{ cubic metres,}\\ &= 3{\cdot}6 \times 10 \times 4{\cdot}1 \times 10 \times 2{\cdot}8 \times 10 \text{ cubic decimetres or litres.}\\ \text{Value} &= 3{\cdot}6 \times 4{\cdot}1 \times 2{\cdot}8 \times 1000 \times 20 \text{ francs.}\end{aligned}$$

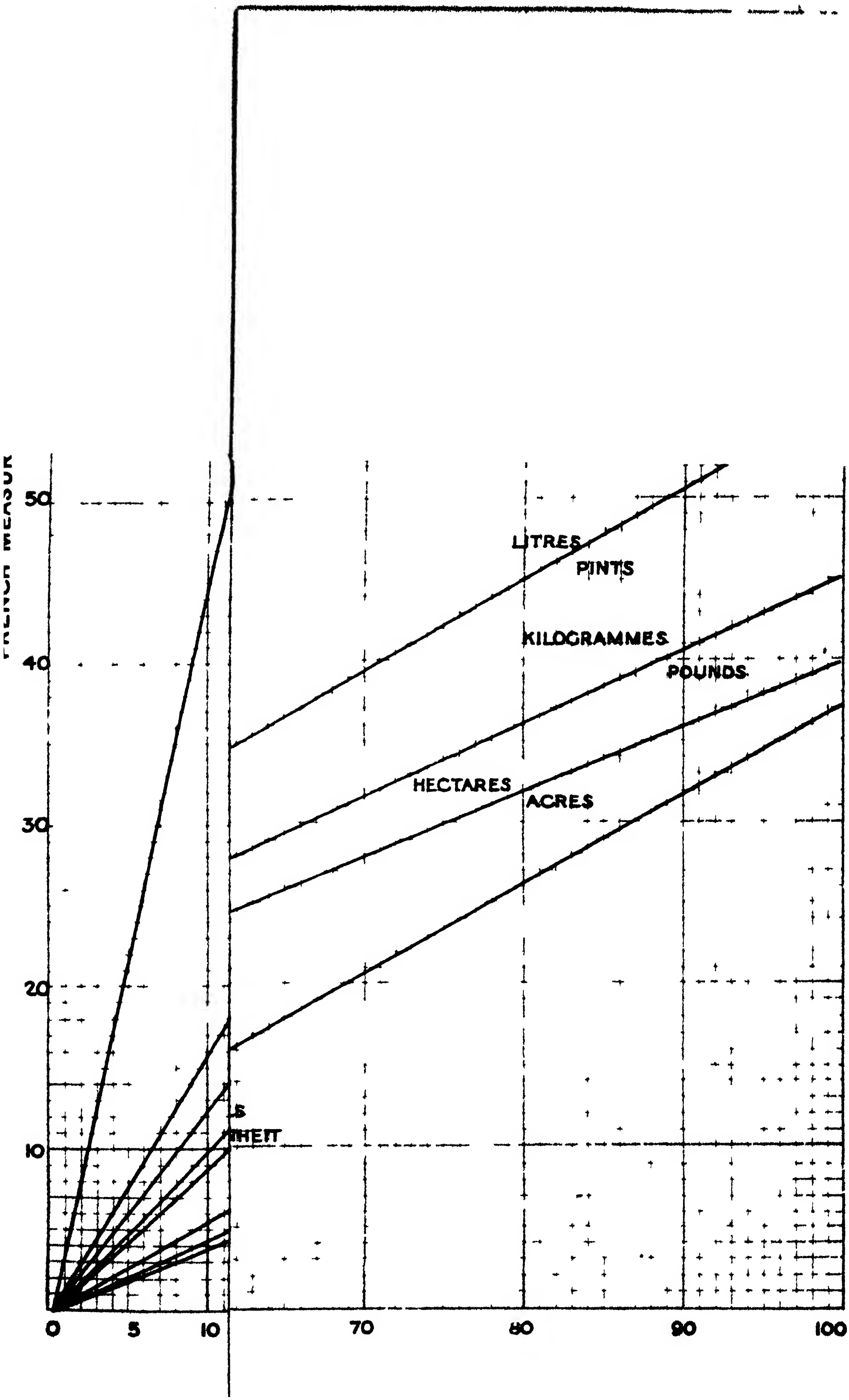
The following approximations may prove useful to readers:—

Acres	×	·4	=	Hectares.
Bushels	×	·36	=	Hectolitres.
Feet	×	3	=	Decimetres.
Gallons	×	4½	=	Litres.
Inches	×	2½	=	Centimetres.
Miles	×	1·6	=	Kilometres.
Ounces	×	·28	=	Hectogrammes.
Pints	×	1·75	=	Litres.
Pounds	×	·45	=	Kilogrammes.
Yards	×	·9	=	Metres.

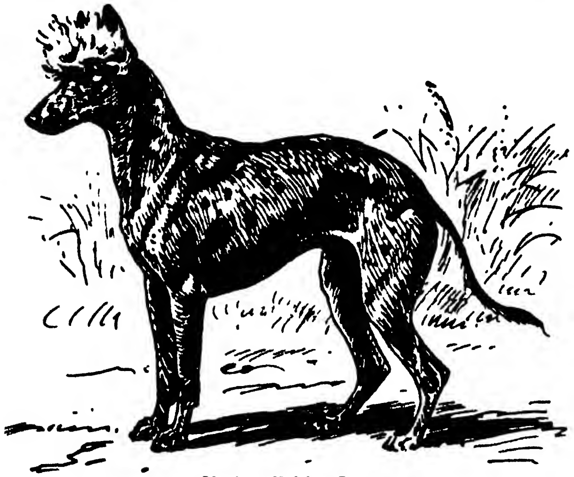
The accompanying Plate gives a means of quickly reducing English measures to their equivalents on the metric system and vice versa. Suppose, for example, that it is required to find the number of kilogrammes in 60 lb. Run the eye up the vertical through 60 on the horizontal scale (English measures) till it encounters the kilogramme-pounds line. The vertical distance traversed indicates the number of kilogrammes, and reference to the vertical scale (French measures) shows it to be slightly over 27. Hence 60 lb. = 27 kilos. Similarly, 60° F. = 15½° C.; 60 acres = 24 hectares, 60 pints = 34 litres, &c. To reduce 40 kilogrammes to pounds, run the eye along the horizontal through 40 on the vertical scale (French measures) till it encounters the kilogramme-pounds line. The horizontal distance traversed indicates the number of pounds. It is about 88, so that 40 kilos = 88 lbs. Similarly, 20° C. = 68° F.; 70 kilometres = 43½ miles; 90 litres = 20 gallons, &c. [R. J. T. B.]

Metritis, that is, inflammation of the womb, is of two kinds, simple and septic. This division had been long accepted, and is convenient to distinguish metritis arising out of accidental causes, from that induced by a specific septic organism or poison in which case the disease is known as dourine. In view of later pathological study it is doubtful if any case of metritis is not caused by some septic influence, but in its invasion, course, and termination we are able to differentiate between the simpler and virulent inflammations of the viscus. Simple metritis is apt to follow on protracted labours or any difficulty calling for forcible interference. The employment of ropes or other cordage that is not clean, and wounds from the finger nails of the accoucheur, are among the causes most frequently inducing metritis. Commencing in the membrane lining the cavity, it soon extends to the walls or substance. It comes on in a few hours after parturition, and in mares is generally fatal. Abdominal pain, as of colic (see COLIC), and unnatural excitement usher in the malady. The mare will sniff at the ground, march round and round the box, with intervals of depression in which the head hangs down, the nostrils are dilated, and the breathing hurried. There is a fetid dark-red discharge from the vulva, and the secretion of milk entirely ceases. A high temperature—as much as 107° F. is observed, or even higher—together with a quick and wiry pulse. Sudden amelioration of the symptoms may be followed by laminitis (see LAMINITIS). The septic metritis is said to be introduced at the time of conception by the stallion. The foal seldom survives many minutes, if it is not stillborn. The placental membranes are a dirty drab colour and quickly expelled. The illness of the mare comes on soon after parturition, with symptoms similar to those described above. If death does not quickly supervene, blood-poisoning and abscesses probably follow. All animals are liable to metritis, the ewe perhaps being the most susceptible of all. All who may have to play the part of accoucheur should wash the hands and cut back the nails, and immerse them in carbolized oil or other antiseptic. All appliances used should be similarly prepared. Syringing the uterus with permanganate of potash, or carbolic lotions, and the administration of hyposulphite of soda, quinine, gentian, and other tonics, with invalid foods, are advised. [H. L.]

Mexican Hairless Dog.—The Mexican Hairless Dog belongs to one of the numerous families of the canine race which possess no hair upon their bodies; in fact, in common with the South African Sand Dog, it grows no coat at all, in which respect it differs from most of the hairless varieties, as the majority of the latter have tufts upon their heads. In general conformation they somewhat resemble the Whippet, but they are much smaller, the average weight being from 8 lb. to 10 lb. The ears are either carried erect or dropped close to the sides of the head, and a peculiarity of these hairless dogs is that their skin always feels cold to the touch. There is always a tendency on the part of the varieties which grow no hair to develop coats after a long residence in this country, the cause doubtless being the coolness of the climate. The coats, however, if they appear, are never long, but partake more of the nature of a short, downy fluff, which bears no resemblance to genuine hair. The most common colour is


LITRES
PINTS
KILOGRAMMES
POUNDS
HECTARES
ACRES
50
40
30
20
10
0
5
10
70
80
90
100

a sort of elephant-grey, and this is often associated with dull pinkish-coloured mottlings, whilst sometimes the pink shade extends almost all over the body. [V. S.]



Mexican Hairless Dog

Micas, a group of minerals occurring as flakes, scales, or six-sided plates in a very large number of igneous and metamorphic rocks; from these rocks, micas become washed out to accumulate again in sandstones, or even in some limestones that are formed in the neighbourhood of older mountain chains. The micas crystallize in six-sided prismatic forms of the monoclinic system, and they break very easily into laminæ along cleavage planes parallel to the base of the prism. These laminæ are transparent and flexible, and those from the large crystals that occur in Russian and Indian granites are used commercially for caps to lamp chimneys, for lamp chimneys themselves, and even as a substitute for window glass. Their glancing surfaces catch the eye as they lie scattered about in clays and sands worn from other rocks. The very common rock mica-schist, resulting from the extreme alteration of clay, is largely made of mica, and may present gleaming surfaces over miles of country.

By slow decay, the micas no doubt add potash to the soil, since they are well supplied with this material, and an ordinary granite, with its potash felspars and its micas, thus looks promising from a chemical point of view. The physical characters of such a soil are, however, unsatisfactory. The ferruginous yellow loams, full of altered micas, which are derived from many schists will be discussed in the article on SCHIST. [G. A. J. C.]

Mice and Voles—Damage to Woodlands.—Mice and voles often do a great deal of damage by devouring seed shed in woodlands or sown in nurseries, and gnawing plants in nurseries and in plantations up to about fifteen to twenty years of age, though oftenest and most in young plantations (especially of beech, saplings up to 1 in. in diameter being often completely gnawed through). The long-tailed, long-nosed mouse (*Mus silvaticus*) gnaws only at roots and within 2 or 3 in. above-ground; but the short-tailed, broad-headed voles (*Arvicola*) can all climb (except the Water-rat, *A. amphibius*, which gnaws the base of stems and exposed roots). These climbing land voles include the True Field-mouse (*A. arvalis*), which migrates from fields to woods in autumn, devours seeds, and gnaws the bark of saplings and poles near the ground, but cannot climb well. The Common Field-vole (*A. agrestis*), which also devours seeds and gnaws bark, is a better climber, and often gnaws higher up; while the Red or Bank Vole (*A. glareolus*) chiefly gnaws, and climbs up 10 or 12 ft. to reach the softer bark. The gnawing of mice and voles near the ground can be easily distinguished from damage by rabbits by the far closer and smaller teethmarks; and the gnawing of the Bank Vole high up can be distinguished from that of squirrels through being smaller and closer, and less regularly perpendicular, while it is generally done in winter (whereas squirrel-gnawing usually takes place in spring and summer, when the sap is in flow). The best way to protect seed in nurseries is to moisten the seed slightly and roll it in red-lead powder before sowing; but when nursery plants and young plantations are attacked, the only effective way of getting rid of such vermin is to lay oatmeal poisoned with phosphorous paste in drain pipes. Damage is always worst in young plantations where there is a strong growth of grass. A great amount of damage was done in the Forest of Dean in 1813–14, also at Rannoch (Perthshire) in 1863–4, and in the south of Scotland generally in 1892 (when a Departmental Committee was appointed to report on it in 1893). [J. N.]

Michaelmas, the 29th day of September. It is a common term of entering on the tenancy of farms in England.

Michaelmas Daisy, one of the larger, coarser species of asters which are largely grown in gardens for autumn effect. See ASTER.

Microcline, a potash felspar commonly found in granitic rocks. See FELSPAR.

Microgaster, an extensive genus of minute ichneumon flies, most serviceable in the field and garden in keeping under some caterpillars which damage the crops.

M. glomeratus, Linn., is especially attendant upon the larvæ of the white cabbage butterfly, in which it lays its eggs; these produce maggots, which consume the fat and muscles, and, when little more than the skin is left, they come through the skin of the caterpillar and form yellow silken cocoons, like those of the silkworms in miniature. The insect expands nearly ¼ in.; it is black and shining, with two antennæ extending as far as the four wings, which are transparent, iridescent, with a brown spot on the pinion edge of the superior; legs ochreous,

hinder thighs black at the apex, shanks and all the feet tipped with brown.

M. lineola, Curt., is similar but smaller; it feeds upon the larvæ of a fly, *Catabomba pyrastri*, and forms white cocoons. Therefore not beneficial, for *C. pyrastri* feeds on aphis. *M. lineola* is black, the spot on the upper wings is tawny, and the legs are dull-ochreous, with a dark line on the back of the hinder thighs; the feet, and sometimes tips of the hinder shanks, are dusky. [J. C.] [F. V. T.]

Middleman.—Some of the talk about eliminating the middleman undoubtedly proceeds from persons who, though they have a certain acquaintance with the industry concerned, possess no deep, practical knowledge of it. There are very few industries which do not find it necessary to have middlemen. The reason is to be found in a fact of human nature. The men who excel as producers do not necessarily excel as traders. It might be added that producers have not always the requisite leisure for profitable trading, and that the tendency of the age is towards efficiency by way of specialization. The great majority of artists cannot make a living without the picture dealer; the very largest restauranteurs buy their fish from factors, not from fishermen; and in the agricultural world there are egg and poultry higglers, pig dealers, cheese, milk, butter, corn, potato, manure, feedingstuffs, hay and straw merchants. The middleman may not be an ideal medium. He is, in fact, one of the compromises of civilization. The necessity for recent fertilizer and feedingstuffs legislation and for the provision of facilities for obtaining cheap analyses from the agricultural colleges, along with the progress of the agricultural co-operation movement, may be held to show that the compromise has not worked with perfect satisfaction to the farmer. And agriculture may carry too many middlemen on its back. But only those who have failed to study the conditions of rural industry closely will underrate the middleman's strong points. Producers have found before today that in abolishing one middleman they have simply called into existence another kind of middleman. And the wide knowledge, often an inherited knowledge of their trades, which middlemen possess, places them at a great advantage when co-operative competition is set up against them. In the case of the agricultural industry it has also to be said that the standard of commercial morality among the bulk of its merchants is high. On the other hand, at the very time of writing a difficulty has been experienced in giving effective publicity to the misdeeds of certain vendors of feedingstuffs. Although wild statements have been repeatedly made in advocacy of the principle of agricultural co-operation, nearly a thousand co-operative societies could not exist in Ireland, nor could there be a successful co-operative movement in England and Scotland, without some justification. So long, however, as many farmers are financed to some extent by their merchants, they cannot expect to be able to command the lowest prices. Such men are not in a position, perhaps, to pay cash and become co-operators. Nor is the movement likely to be supported by a farmer of a type known to the writer who did not realize the uneconomical character of his proceedings in offering in person the same sample of corn to the same merchant at four different market towns in the same week! But farmers in more independent circumstances and of a more up-to-date turn feel that they have something to gain by well-considered association for the purchase of requirements and the sale of produce. It may be that credit banks will prove an effective support to co-operation in this country, but the methods of profitable banking are not learnt in a day. By way of addition to the facts mentioned in the article on CO-OPERATION (which see) it may be stated that the Ipswich Society, the members of which till an average of 300 ac., did, in the first half of 1909 £124,000 worth of business in all departments; and that the new Joint Board for Ireland, England, and Scotland, for trade within the movement, is steadily establishing its position. With regard to plans for the "direct supply of produce to consumers", experience seems to show that the practical convenience of dealing, in a perfectly untrammelled way, with shops and stores, where there is choice and variety, is likely to limit the development of this system in a highly organized community. A combination of small holders on a sufficiently large scale may be able, however, to offer customers the necessary variety, but this is yet to be demonstrated. Except in the matter of, say, eggs and butter, a single farmer can do little himself. ['H. C.']

Middle White Pigs are said to produce 'porket' pigs of fine quality and possessing a good proportion of lean meat, at less cost and in less time than any other breed of pigs. This small fat pig of 90 to 100 lb. gross can be produced from a Middle White sire and dam or from a Middle White sire and a Berkshire dam, ere the youngster has exceeded eighteen weeks old. In the same way the Middle White pigs, either pure or when the boar is mated with the Berkshire sow, will breed pigs which at seven to eight months will weigh 200 to 250 lb., furnishing a carcass of the finest quality meat for the fresh pork trade. Of course in these instances the parents must be selected for their good qualities, and the produce kept in a growing and fatting stage during their short life. At the Smithfield Club's show in London, the best cross-bred pigs are generally by Middle White boars. The show of 1908 was no exception, as the breed cup-winners in the cross-bred section were by a Holywell-bred Middle White boar, as well as the first-prize winner in the class for one cross-bred pig. The last-named pig was identical in form, type, and character with its sire, save that it had several blue spots on the skin. There is little doubt that into the blood of the Middle White pigs some breeders did, prior to general registration, introduce alien blood under the mistaken idea that improvement on certain points would result. Disappointment to the experimenter and injury to the particular breed have generally followed. The chief points which the really good Middle White pig is said to possess in a

[illegible]

MIDDLE WHITE BOAR WALTON TURRET 7TH

WINNER OF FIRST PRIZE AND CHAMPION, R.A.S.E. SHOW 1905

Photo. Chas. Reid

MIDDLE WHITE SOW WALTON ROSE 39TH

WINNER OF FIRST PRIZE AND CHAMPION, R.A.S.E. SHOW, 1907

marked degree are prolificacy, docility, early maturity, and fineness of bone and offals, and on the part of the sow, the ability to supply its young with plenty of milk. The general formation should be as follows: head wide, nose short and turned up, jowl full, neck short, shoulders light and obliquely placed, ribs well sprung, body long, quarters square and full, flank thick, hair silky, and skin and bone fine. [S. S.]

Middlings.—This is one of the offals of wheat. It is difficult to discriminate between the various offals of wheat and to say exactly what each is, inasmuch as they are known by different names according to the demand at a particular time, and also according to the separation processes in use at particular mills. Bran is the coarsest of the offals, then follows pollards, next sharps, and then middlings. The composition, too, will vary, and no definite analysis can be set out for middlings that would not apply more or less to other offals approaching it in respect of fineness. Middlings are principally used for pig-feeding. They are sometimes divided into 'coarse middlings' and 'fine middlings', the latter fetching often 15*s.* to £1 per ton more than the former. While the 'coarse middlings' are used for pigs generally, and the price varies according to demand and supply, 'fine middlings' are given mainly to breeding pigs and to the finer qualities. They are favoured because they have more of the flour left with them, and also the 'germ' is cut up with and retained in them. The 'germ', if separated out, is employed mainly for making 'Hovis' bread. Like other offals of wheat, middlings are not unfrequently adulterated, cheaper grain, such as barley meal, ground oats, rice meal, or even rice husk, being mixed with them. Occasionally grosser admixtures, such as sawdust finely ground, gypsum and other mineral matters, are employed. The freedom of middlings from natural impurities will depend in large measure upon the quality of the wheat used, and on whether this has been a clean sample and properly freed from weed seeds and the like. Among the common weed seeds found to be present are Polygonum, Corn Cockle, and Chenopodium. Sometimes, too, excessive sand is present.

The following analysis represents the general composition of middlings:—

Moisture	12·04
Oil	4·02
[1] Albuminous compounds	16·53
Starch, digestible fibre, &c.	59·85
Woody fibre	4·06
Mineral matter (ash)	3·50
	100·00

[1] Containing nitrogen ... ... 2·65

[J. A. V.]

Midge, the popular term applied to a large number of minute dipterous flies. The common household midge or gnat is described in the article CULEX, the Pear Midge under the title DIPLOSIS. See also under MOSQUITO.

Mignonette (*Reseda odorata*, nat. ord. Resedaceæ), a native of North Africa, introduced 1752, when the flowers were yellowish-white, but by cultivation and selection varieties approaching to white, and also to yellow, orange, and red, have been evolved. Very useful for cutting, this delightfully fragrant little plant is one of the most popular of hardy annuals. To attain to perfection it requires good soil and rigorous thinning, with plenty of moisture, and, as is the case with other hardy annuals, these points are very often overlooked. Sowing should be made in April and May, and again in July for a late-flowering display, and always on as generous a scale as space permits. Mignonette is also largely grown under glass for market, both for the cut flowers in early spring and for sale as pot plants. The seeds are sown in September in the flowering pots, a compost containing mortar rubbish and cow manure being used. The best varieties are Golden Queen and Cloth of Gold, yellows; Parson's White and Garaway's White; Improved Machet, Bismarck, and Crimson King, reds. [W. W.]

Mikiola fagi (the Beech Nail Gall), a small gall midge common to Europe, but most abundant in Britain and Switzerland. In length it is from $\frac{1}{8}$th to $\frac{1}{6}$th of an inch; in colour it is blackish-brown, with flesh-coloured abdomen and grey hairs, and the brownish wings have grey hairs. It is called the Beech Nail Gall because the larvæ form horn or nail-shaped galls on the upper side of the beech leaves. As many as twenty may occur on each leaf, which turns yellow and falls prematurely. The galls fall from the leaves, and the small larva within each gall pupates there, and from these the brood of the succeeding year appear. Ornamental beech are damaged by this insect, which can be checked by collecting and burning all winter refuse beneath the trees, and digging the soil over as deep as possible. In a park all that can be done is to burn the leaves under the trees in winter. Many of the galls are then destroyed. [F. V. T.]

Mildew. — This word is used (or rather misused) in a popular way to indicate any kind of coating or discoloration on plants, cloth, or indeed any substratum. Mildew of cloth appears as whitish, grey, or dark spots on the fabric, and is a frequent source of trouble when cloth goods are exported by ship; in many cases it is due to the growth of minute fungi, and is the result of imperfect drying or finishing, or of storage in a damp place. 'Mildew' as used in books on agriculture and horticulture to describe mouldy growths on plants, is also applied without discrimination. Mildew of wheat may mean either a yellow rust or a white powdery coating (see WHEAT—PARASITIC FUNGI). The rule in recent works is to limit the use of the word to two groups of fungi, viz.: (*a*) Downy Mildew or Peronosporeæ (for illustrations see art. FUNGI, and refer to arts. on POTATO, CLOVER, PEA, GRAPE-VINE, &c., PARASITIC FUNGI); (*b*) Powdery Mildew or Erysipheæ (see art. FUNGI, also arts. on ROSE, GOOSEBERRY, PEA, GRAPE-VINE, &c., PARASITIC FUNGI). [W. G. S.]

Milfoil. See YARROW.

Milk.—COMPOSITION.—The sole nourishment of the young of mammals, milk has a composition which provides for all the life processes, both

anabolic and metabolic, of the infant. Though the milks of all mammals have many points of resemblance, and may all be considered as of the same general type, there are important differences. The milk of the cow, on account of its universal use, has been studied in much greater detail than that of any other animal, and it will be convenient to describe this milk, and later to point out in what respects the milk of other mammals differs from cow's milk.

Colour.—Milk is an opaque white liquid; the opacity is partly due to particles in suspension —fat globules, leucocytes, and epithelial cells— and partly to the presence of a molecular compound of casein with calcium phosphate which exists in pseudo-solution, *i.e.* in such a condition that it does not settle out on standing, but can be removed by filtration through a very close medium.

Reaction.—It has an amphoteric reaction to litmus paper, *i.e.* it turns blue litmus paper slightly red, and red litmus paper slightly blue. This reaction has been the cause of endless confusion, and perhaps no more striking instance of the old adage, 'a little learning is a dangerous thing', can be found than is afforded by the use of blue litmus paper to test milk; undoubtedly immense quantities of fresh milk have been condemned as sour by the ignorant dipping of a piece of blue litmus paper into milk. The explanation of the amphoteric reaction of milk is this: the acidity of milk is due to the presence of mono- and dibasic phosphates and citrates of sodium and potassium, which are very feeble acids and of about the same strength as is litmus. Litmus is a red acid, with a blue sodium or potassium salt, and red litmus is more acid than milk, while blue litmus is more alkaline; when blue litmus paper is dipped into milk, a portion of the alkali of the blue salt passes to the milk to establish equilibrium, and the litmus becomes slightly reddened; if red litmus is used, a portion of the alkali of the salts of the milk passes to the litmus, and turns it slightly blue. It is quite impossible to use blue litmus paper as a test for the acidity of milk, as the degree of alkalinity of this varies considerably, but red litmus paper is of some use; milk which does not turn red litmus slightly blue has developed a certain degree of acidity.

The acidity of milk is measured by means of a tenth normal alkaline solution, using phenolphthalein as indicator; a faint pink colour shows when the acidity is neutralized. Acidity is usually expressed in degrees, which correspond with the number of cubic centimetres of $\frac{N}{10}$ alkali to neutralize 100 c.c. of milk. The average acidity is 20 degrees, and does not vary much from this figure; occasionally it is found to be very much lower, though this usually indicates an unhealthy condition, and sometimes in milk very rich in protein constituents it is distinctly higher. See art. ACIDIMETER.

When milk is kept it gradually becomes sour from the development of lactic acid by micro-organisms; the rate at which souring takes place is generally very constant, and depends practically only upon the temperature. The following table gives the rate of development of acidity in milk, with time.

TABLE SHOWING THE NUMBER OF HOURS MILK REQUIRES TO REACH THE ACIDITIES ABOVE THE NORMAL NAMED.

Acidities.	Number of Hours.			
	60° F.	70° F.	80° F.	90° F.
10	44	29	19	13
13	47	31	21	14
20	50	33	22	15
30	53	35	23	16
40	56	37	25	17
50	60	40	27	18
60	66	44	29	19
70	80	53	35	23
80	100	67	44	30
90	142	94	63	42

When about 13 degrees of acidity have been developed by micro-organisms, milk curdles when raised to the boiling-point; at about 25 degrees of acidity above the initial acidity the increase of micro-organisms in milk ceases, though they are still able to produce lactic acid; and at about 65 degrees the milk curdles spontaneously, but this last point is not so well marked as the others, curdling taking place sometimes at least 5 degrees above or below 65 degrees.

Fat Globules.—The diameter of the fat globules in milk varies from 0·01 mm. to 0·0016 mm. It is now definitely established that there is no membrane around the globules as was formerly supposed, except in so far as the liquid layer which is condensed by surface energy of small particles can be considered as a membrane. At temperatures above the melting-point of the fat (about 32° C.) the fat is liquid; when the milk is cooled the fat very slowly solidifies; as the density of fat is appreciably greater (about 0·008) in the solid state than when liquid at the same temperature, the slow solidification of the fat is made manifest by the slow rise in density of the milk, known as Recknagel's phenomenon.

When milk is cooled down immediately after milking to as low a temperature as possible, the density of the serum is raised to the highest possible point, while the density of the fat, owing to its liquid condition, is at a minimum; there is consequently a maximum difference between the densities of the fat and the serum, and this is the condition necessary for the most rapid rising of the fat globules as cream.

Leucocytes, Epithelial Cells, &c.—In common with all other animal tissues, milk contains large numbers of white corpuscles or leucocytes, the presence of which important constituents of milk has only comparatively recently been recognized. These are of the same kind, and morphologically indistinguishable from the leucocytes present in blood or in pus, and the numbers of them in milk from perfectly healthy animals is often large, sometimes exceeding a million per cubic centimetre. That they are alive in milk when drawn from the udder, and that they still exercise their characteristic function of attacking and destroying micro-organisms, is shown by the

well-known germicidal property of fresh milk; it has frequently been observed that, during the first few hours after milking, there is a marked decrease in the number of micro-organisms present.

In addition to the leucocytes there are often present epithelial cells from the udder, and it is probable that these are sometimes confused with the leucocytes; numbers of the empty cells in which the milk was secreted are likewise found.

All these constituents are heavier than the milk serum, and are removed to a large extent by centrifuging, and form a large portion of the 'separator slime' or deposit found on the inside of the drum of a separator after use. A considerable portion is, however, carried up with the cream; cream which rises when the milk is set probably contains the whole of the leucocytes and other cells entangled with the fat globules.

There is little doubt that the alarming statements which have appeared from time to time in the press as to the unhealthy condition of the milk supply, and the enormous proportion of samples containing pus, have been due to a mistaken diagnosis, and a failure to appreciate the fact that leucocytes are normal constituents of milk, and that small clusters of epithelial cells may be mistaken, if stained by the ordinary methods, for polynuclear cells.

Enzymes.—Besides the living cells, and probably closely associated with them, milk contains several unorganized ferments or enzymes. These consist of a proteolytic enzyme, which digests casein, and which probably plays a part in the digestion of milk in the stomach; a catalase, which liberates oxygen from hydrogen peroxide; and a peroxydase, which in the presence of hydrogen peroxide oxidizes various substances. There are also other enzymes present, but it is not quite certain that these are not formed by the micro-organisms which are always present in milk. It is not impossible that in reality there is only one enzyme in milk, which has several functions. The enzyme or enzymes and the leucocytes are all destroyed by heating the milk to a temperature of 80° C.

Proteins.—Among the most important constituents of milk from a technical, as well as from a scientific and dietetic, standpoint are the proteins. Recent work on the proteins, notably by Emil Fischer and his pupils, has shown that they consist of a large number of molecules of amino acids condensed together. The more important of these are:—

1. Amino acids of the acetic series, of which glycine, or amino-acetic acid (which, however, does not occur in casein, and probably not in the other milk proteins), may be taken as the type; its formula is—

$$\begin{matrix} CH_2\text{—}COOH. \\ NH_2 \end{matrix}$$

Glycine readily (and its higher homologues somewhat less readily) condenses to form an anhydride, which is a diketo-piperazine:—

$$CH_2 \begin{matrix} \diagup NH\text{—}CO \diagdown \\ \diagdown CO\text{—}HN \diagup \end{matrix} CH_2.$$

These diketo-piperazine groups occur in the protein molecule.

The condensation of these acids also takes place in chains as well as in closed rings, and it is probable that the protein molecule consists of long chains containing the group

$$\begin{matrix} \text{—CH—NH—CO—CH—} \\ \quad | \qquad\qquad\qquad | \end{matrix}$$

many times. Leucine, or α-amino-iso-caproic acid, occurs in the largest amount.

2. Basic amino acids, of which the most important are: Lysine, or αε-diamino-caproic acid; arginine, or δ-guanidine-α-amino-valeric acid; and histidine, or β-imido-azol-α-amino-propionic acid.

These substances are very important, and constitute an appreciable portion of the protein molecule.

3. Acid amino acids, of which glutamic acid, or α-amino-glutaric acid, is the most important; it occurs in considerable amounts in casein.

4. Aromatic amino acids. Of these the most important are: Tyrosine, or oxy-phenyl-α-amino-propionic acid; tryptophane, or indol-amino-propionic acid; and proline, or α-pyrrolidine-carboxylic acid.

5. Amino acids containing sulphur, of which cystin is the most important; this is produced by the condensation of two molecules of cystein —amino-thio-lactic acid.

By the action of hydrolysing agents such as enzymes, acids, alkalis, proteins are split up into simpler compounds by the breaking of the —NH—CO— chains, with the formation of $-NH_2$ and —COOH groups; by this means, proteoses, peptones, polypeptides, and eventually the amino acids, are produced.

Different hydrolysing agents act on different groups of the molecule; thus by the action of trypsin, the proteolytic ferment of the pancreas, tyrosine is readily and completely separated, and tryptophane is also split off at an early stage.

The proteins of milk number at least four. The most important is casein, which is contained to the extent of 3·0 per cent; lactalbumin, of which about 0·4 per cent is found in milk, is next in importance; while lacto-globulin and mucoid exist only in traces.

Casein belongs to the group of phospho-proteins, and behaves as a substituted phosphoric acid. It has well-marked acid properties, and appears to be a tribasic acid; in milk it exists as a molecular compound of the calcium sodium salt with calcium phosphate. The free acid is precipitated by the addition of an excess of acid to milk in the cold; about 60 c.c. of N hydrochloric or sulphuric acid per litre of milk is sufficient to precipitate the casein in a form practically free from calcium or sodium.

When 8·3 c.c. of N acid are added to milk, it curdles when raised to the boil, but the precipitated curd then consists of a molecular compound of monacid-dicalcium casein with calcium phosphate. At 75° C. 15 c.c. of acid are required, and at 40° C. 40 c.c. The curd precipitated at these temperatures is intermediate between that

precipitated on boiling and that prepared in the cold.

Casein has also the property of being curdled by rennet. Rennet is a hydrolytic ferment which splits up casein into various proteoses. If a solution of casein free from calcium is prepared, it is split up by rennet into comparatively simple compounds. In milk, however, the fission stops at the stage when curd is precipitated; this is the monacid dicalcic compound of a comparatively little-altered derivative combined with a molecular proportion of calcium phosphate; it is the insolubility of this compound that causes the stoppage of the action. The other compound (or mixture of compounds) formed is whey protein, a comparatively simple body.

Casein has very feebly basic properties, due to the presence in the molecule of free amino groups, and if treated with an excess of acid, forms a very feeble and easily dissociated compound therewith.

Lactalbumin is not precipitated by acids, but in feebly acid solution is coagulated by raising the temperature to 70° C.; when milk is heated to 70° C. no lactalbumin is deposited, as it probably exists in milk as a salt, but it is converted into a soluble modification, which is precipitated on the addition of acid.

The mucoid protein of starch is insoluble and exists in a swollen state; very possibly it is an impure mixture of proteins derived from the leucocytes and epithelial cells.

Sugar of Milk.—The sugar in milk—lactose—is a hexa-biose, and contains galactose and glucose condensed to one molecule; the condensation takes place at the aldehyde group of the galactose.

It exists in two modifications having specific rotatory powers $[\alpha]_D$ of 33° and 84° respectively, each of which, on solution in water, gradually changes to a stable equilibrium form having an $[\alpha]_D$ of 52·53°.

Milk sugar is not very soluble in water. By shaking up an excess of milk sugar with water, a solution containing 7·5 grm. per 100 c.c. is obtained; but by long standing or by boiling, a saturated solution containing 21·6 grm. per 100 c.c. is eventually produced. It reduces Fehling's solution on boiling, but not so readily as most other sugars.

On boiling with moderately concentrated acids it is converted into a mixture of galactose and glucose, and the same change takes place under the influence of the enzyme of kefir grains—lactase.

Mineral Constituents.—The mono- and dibasic phosphates and citrates have already been referred to as the constituents to which the acidity of milk is due, and the calcium phosphate as being in combination with the casein. Of the other mineral constituents the most important are the chlorides, which exist in small quantities. There is also a trace of iron present, which, though small in amount, is doubtless of great importance in nutrition.

The ash left on igniting milk does not quite represent the mineral constituents; the citric acid is entirely destroyed on ignition, and the phosphorus of the casein is converted into phosphoric acid, which neutralises the carbonates into which the citrates are converted.

Variations of Composition.—It is but rarely that complete or fairly complete analyses of milk are made, and many of the constituents are practically never estimated; the mean composition and the maxima and minima observed are as follows:—

	Mean.	Maximum.	Minimum.
Fat	3·75	12·52	1·04
Milk sugar	4·75	0·6	5·4
Casein	3·00	?	?
Albumin	0·40	?	?
Mineral matter ...	0·75	0·94	0·6
Total solids	12·75	?	?
Solids not fat ...	9·00	10·5	4·9
Specific gravity ...	1·0322	1·0397	1·0135

The variations given above are the extremes, and are much greater than are generally found.

The composition of milk varies from month to month; that of May and June is the poorest, while the milk in the latter months of the year is the richest.

The morning milk is always poorer than the evening's, the average difference being 0·4 per cent in the fat. The difference depends largely, though not entirely, upon the difference in times between the two milkings; the mean difference is 10·8 hours from the morning to the evening, and 13·2 from the evening to the morning. When the intervals are more widely divergent there may be a larger difference between the percentages of fat of the two milkings, sometimes exceeding 1 per cent.

The table on p. 11 gives the average composition of the milk examined in the Aylesbury Dairy Company's laboratory during 1908; the composition of the morning and evening milks is given separately, and the results are the averages for each month.

There is also a slight difference in the percentage of fat on the various days of the week; the averages are:—

Day:—	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat	Sun.
Per cent fat	3·70	3·78	3·75	3·75	3·75	3·73	3·74

It is seen that Monday's milk is the lowest in fat. This is probably partly due to a disturbance in the usual interval between the Sunday evening's and Monday morning's milkings, and partly also to the effect of the Sunday holiday on the milkers. The rise of fat on Tuesday, which is equally as well marked as the fall on Monday, is less easy to account for.

The breed of the cow has a great influence on the composition of the milk. The percentage of fat, which is the most variable constituent, in the milk of a few breeds is given below:—

Jersey	5·29	Ayrshire	3·96
Guernsey ...	5·09	Shorthorn ...	3·87
Kerry	4·70	Dutch	3·64
Welsh	4·65		

The cows giving milk containing percentages of fat above 4 are not very numerous, and con-

Composition of Milk during 1908

Month.	Morning Milk.				Evening Milk.				Mean.			
	Specific Gravity.	Total Solids.	Fat.	Solids not Fat.	Specific Gravity.	Total Solids.	Fat.	Solids not Fat.	Specific Gravity.	Total Solids.	Fat.	Solids not Fat.
January	1·0323	12·61	3·66	8·95	1·0321	12·96	3·99	8·97	1·0322	12·79	3·83	8·96
February	1·0322	12·46	3·55	8·91	1·0320	12·79	3·87	8·92	1·0321	12·62	3·71	8·91
March	1·0322	12·47	3·55	8·92	1·0320	12·80	3·88	8·92	1·0321	12·64	3·72	8·92
April	1·0329	12·39	3·50	8·89	1·0318	12·67	3·81	8·86	1·0320	12·53	3·65	8·88
May	1·0323	12·30	3·41	8·89	1·0318	12·73	3·86	8·87	1·0320	12·51	3·63	8·88
June	1·0324	12·17	3·29	8·88	1·0317	12·57	3·76	8·81	1·0320	12·37	3·52	8·85
July	1·0318	12·16	3·40	8·76	1·0311	12·48	3·81	8·67	1·0314	12·32	3·60	8·72
August	1·0317	12·25	3·50	8·75	1·0310	12·73	4·03	8·70	1·0313	12·49	3·76	8·73
September	1·0319	12·50	3·65	8·85	1·0314	12·97	4·14	8·83	1·0317	12·74	3·90	8·84
October	1·0322	12·58	3·66	8·92	1·0319	13·08	4·15	8·93	1·0321	12·88	3·90	8·93
November	1·0325	12·69	3·70	8·99	1·0322	13·10	4·10	9·00	1·0323	12·90	3·90	9·00
December	1·0326	12·76	3·75	9·01	1·0322	13·04	4·05	8·99	1·0324	12·90	3·90	9·00
Average ..	1·0322	12·44	3·55	8·89	1·0318	12·83	3·95	8·88	1·0320	12·63	3·75	8·88

tribute but a very small proportion to the milk supply of the country.

Milk as drawn from the cow is not homogeneous; the first portions or fore milk contain less fat than the average, and a fairly large number of microbes; as the milking proceeds the amount of fat rises, and the last portions or strippings may be quite rich, containing over 10 per cent. The last portions of the milk are nearly sterile, and sometimes quite sterile; it is probable that milk when secreted is sterile, but the milk duct always contains microbes which find entrance from the outside, and the milk is contaminated on its passage.

Variations of Fat on Standing.—Owing to the fat globules being lighter than the milk serum, they rise when the milk is allowed to remain at rest, and a layer of cream is formed.

Legal Standard for Milk.—The Sale of Food and Drugs Act, 1899, sect. 4, gives power to the President of the Board of Agriculture to fix standards for milk and milk products; a departmental Milk Standards Committee was appointed to make enquiry as to what standards could be made, and the report of this Committee was accompanied by a minority report; eventually the standards of 3·0 per cent of fat and 8·5 per cent of solids not fat were fixed, presumably as a compromise between the majority and minority reports of the Committee, as neither report recommended these figures.

These standards are not, however, absolute, as the rather peculiar wording of sect. 4 is that 'a presumption is raised, till the contrary is proved, that the milk is not genuine'; the 'proof' required in different courts is very varied, and in some cases the interpretation of the section is very lax, while in others it is just the reverse.

So far as the watering of milk is concerned, the standard of 8·5 per cent is a reasonable one, and inflicts practically no hardship on the honest producer, while it allows very little watered milk to escape detection. It is quite otherwise, however, with the 3·0 per cent standard for fat. As a means of detecting a fairly large removal of cream, or, what is really the same thing, addition of separated milk, it utterly fails provided the adulteration is carried out with reasonable care; while on the other hand it condemns a considerable proportion of genuine morning milk during the spring and early summer months, when, it is now definitely proved, the milk of quite large herds may sometimes fall appreciably below 3·0 per cent in fat.

Ignorance or want of care may also lead to milk containing *less than* 3·0 *per cent of fat.* The natural tendency of cream to rise must be constantly counteracted by stirring or other means, if the composition of a bulk of milk is to be kept constant during sale; and it is undoubtedly true that many prosecutions for the sale of adulterated milk have been brought against vendors who have at the most only been guilty of ignorance or lack of care. It is also true that sometimes grave injustice is inflicted on an innocent farmer, who has given a warranty that the milk he has supplied to a dairyman is genuine; in some cases in which deficiency of cream has been really due to the ignorance or carelessness of the dairyman, who has not kept the milk stirred, the farmer's warranty has been pled as a defence, with the result that the farmer has been summoned and convicted of giving a false warranty.

It is apparent that the state of the law as to the adulteration of milk by removal of the cream is far from satisfactory and requires reform. It is suggested that the following provisions would be preferable:—

(*a*) No warranty should be applicable to any article of food except when sold in unopened packages.

(*b*) The laying down of fixed standards of fat for different grades of milk, *e.g.* ordinary milk 3·0 per cent fat, nursery milk 4·0 per cent fat. For selling milk below standard, the vendor should be summoned privately before the local authority, who should have power to inflict a fine. The vendor should have the right of appeal to a court of summary jurisdiction.

(*c*) The grading of milk by the addition of separated milk or cream, as might be required, should not be an offence.

The Milk of Mammals other than the Cow.—

Milks may be divided into three classes: one, which in addition to that of the cow includes those of the goat, the buffalo, and the sheep, gives a curd with rennet; and a second, which gives no real curd, contains little proteins and much sugar. In the second class are included human milk, and the milk of the mare and the ass; a third class includes the milk of marine mammals.

Class I. Curd-forming Milks.—These milks all have an amphoteric reaction, contain casein in combination with phosphate of calcium, and are fairly rich in fat, which contains a considerable amount of volatile acids.

The composition is given below:—

	Water.	Fat.	Sugar.	Proteins.	Ash.
Goat	86·04	4·63	4·22	4·35	0·76
Buffalo	82·63	7·61	4·72	4·14	0·90
Gamoose or Egyptian Buffalo ...	84·10	5·56	5·41	3·86	0·85
Sheep	79·46	8·63	4·28	6·68	0·97

Class II. Milks giving no Real Curd.—These milks are distinguished by having an alkaline reaction, containing a protein which probably differs from casein in containing less phosphorus, which is not in combination with phosphate of calcium, and which gives a fine precipitate with acids; the fat is generally lower in this class than in the previous one. There is also a difference in the composition of the fat, the proportion of volatile acids being low.

The composition of the most important representatives of this class is—

	Water	Fat.	Sugar.	Proteins	Ash.
Human	88·20	3·30	6·80	1·50	0·20
Mare	89·80	1·17	6·89	1·84	0·30
Ass	90·12	1·26	6·50	1·66	0·46

Human milk as the natural food of infants presents some interest. It is remarkable that there is a gradual slight fall in the percentage of proteins as lactation proceeds, although in the artificial feeding of infants it is found that a gradual increase in the proteins gives good results. It is found that, except in cases where the secretion of milk is deficient, the composition of milk taken before and after the infant has suckled is practically identical.

The sugar of human milk is not entirely milk sugar, and there is another carbohydrate present of which little is known.

Class III. Milk of Marine Mammals.—A very high percentage of fat characterizes the milk of marine mammals; there is a difference in the composition of the fat, as, whereas the principal volatile acid of the fat of terrestrial mammals is butyric acid, that of the fat of marine mammals is valeric acid.

The composition is—

	Water.	Fat.	Sugar.	Proteins.	Ash.
Porpoise	41·11	48·50	1·33	11·19	0·57
Whale	48·67	43·67	7·11		0·46

Analysis of Milk.—To determine whether milk is genuine or adulterated it is usual to determine the specific gravity, the total solids, the fat, and by difference the solids not fat; as confirmatory evidence, the milk sugar, the proteins, and the ash, which are the chief constituents of the solids not fat, may be determined.

Specific Gravity.—This is most rapidly estimated by means of a lactometer—a hydrometer of limited scale; this is placed in the milk, and the point at which the surface of the milk cuts the scale is noted. As by capillary attraction the milk is drawn up around the stem, the exact point at which the surface would cut the scale cannot be seen, but must be mentally estimated, or the point where the top of the meniscus occurs is read, and a constant correction added on. With an open scale and with care and experience, considerable accuracy in reading can be obtained.

As specific gravities are always expressed as at 60° F., it is necessary to take the temperature of the milk, and should this not be 60° F. a correction must be made.

The following table serves for the corrections:—

Degrees of Temperature.	Degrees of Lactometer.									
	26	27	28	29	30	31	32	33	34	35
40	24·5	25·4	26·3	27·2	28·1	29·1	30·0	30·9	31·8	32·7
45	24·8	25·8	26·7	27·7	28·6	29·5	30·4	31·4	32·3	33·2
50	25·1	26·1	27·0	28·0	29·0	29·9	30·9	31·8	32·8	33·7
55	25·5	26·5	27·5	28·5	29·4	30·4	31·4	32·4	33·4	34·3
60	26·0	27·0	28·0	29·0	30·0	31·0	32·0	33·0	34·0	35·0
65	26·6	27·6	28·6	29·6	30·7	31·7	32·7	33·8	34·8	35·8
70	27·2	28·2	29·2	30·3	31·3	32·4	33·4	34·5	35·5	36·5
75	27·8	28·9	29·9	31·0	32·1	33·2	34·3	35·3	36·4	37·4

The table is used by finding in the top line the nearest whole degree of the lactometer, and in the first column the nearest temperature; at the intersection of the corresponding lines will be found the specific gravity corrected to 60° F. Thus 31 degrees of the lactometer at 65° will mean a specific gravity at 60° F. of 31·7.

If the lactometer records an intermediate figure, the decimals must be added on to the corrected specific gravity—thus 31·5 degrees at 65° F. will mean a corrected specific gravity of 31·7 + 0·5 = 32·2.

For intermediate temperatures an allowance which is usually close to 0·1 lactometer degrees

for each degree of temperature must be made; thus 31·5 degrees at 67° F. may be taken as 32·4 or 32·5.

A more exact method of determining specific gravities is to weigh a known volume, *e.g.* in a Sprengel tube. This is filled with milk, immersed in water of a temperature of 60° F., and when the volume has ceased to change, the milk is adjusted to the line engraved on the tube; the tube is dried and weighed, the weight of the empty tube subtracted, and the difference divided by the weight of water that the tube holds at 60° F.

Total Solids.—5 grm. or thereabouts of milk are weighed into a capsule or basin of platinum, aluminium, or porcelain, and evaporated to dryness on a waterbath. The basin should be flat-bottomed, to give as large a surface as possible, and the skin which forms as the milk is heated may be broken with a needle. When apparently dry, the basin is placed in a drying oven for three hours, cooled, and weighed; it is then replaced in the drying oven for one hour, and reweighed, and if the loss is less than 1 mg., again dried for further periods of one hour, till the loss is within a milligramme.

Fat.—The estimation of fat by the Gerber method, which is sufficiently accurate for many purposes, is described in art. Milk Testers.

For more exact determinations the Gottlieb method can be recommended. 5 grm. of milk are placed in a tall stoppered cylinder of about 50 c.c. capacity, 0·5 c.c. of ammonia (equal parts of 0·880 ammonia and water) added, and the tube shaken; 5 c.c. of alcohol (methylated spirit, if free from petroleum, will serve) are measured in, and the tube again shaken; 12½ c.c. of ether are added, and the contents of the tube thoroughly mixed, the thorough mixing at this stage being a condition essential to success. 12½ c.c. of petroleum ether (boiling-point below 60° C.) are poured in, and the contents again mixed. An ethereal layer rapidly separates, which contains the whole of the fat; as much as possible of this is drawn off, preferably by wash-bottle tubes, into a flask, and the residue washed out by three successive additions of a mixture of ether and petroleum ether (the recovered solvents serve admirably). The solvents are evaporated, and the fat in the flask dried to constant weight. As traces of substances other than fat are removed from the milk by the ether or petroleum ether, it is advisable to wash out the flask with a little petroleum ether, and weigh and subtract the minute residue; this is, however, very minute, and neglect of the final stage does not introduce an important error.

Solids not Fat are determined by subtracting the percentage of fat from the total solids.

When the total solids have not been determined, or if a check on this determination is desired, the solids not fat may be calculated from the specific gravity corrected to 60° F. and the fat. A simple formula is—

$$\text{Solids not fat} = \frac{G}{4} + \frac{F}{5} + 0{\cdot}14.$$

G = lactometer degrees, F = percentage of fat.

The solids not fat calculated from this formula usually agree with those determined from the difference between the total solids and the fat within 0·2 per cent with mixed milks. An absolute agreement cannot be determined, as not only is the result affected by errors in the determination of the specific gravity and fat, but it depends on the specific gravity of the fat and the solids not fat, which vary slightly in different milks. The formula is based on average specific gravities.

Milk sugar is best estimated by the polariscope. It is necessary to remove completely the fat and proteins, and this is accomplished by the addition of mercuric nitrate. To carry out a determination, to 100 c.c. of milk are added—

(*a*) A quantity of water in cubic centimetres equal to one-tenth of the lactometer degrees.

(*b*) A quantity of water in cubic centimetres equal to the percentage of fat multiplied by 1·11.

(*c*) A constant quantity of water to convert scale readings into percentages (if an instrument graduated in angular degrees is used, this is 10·85 c.c.).

(*d*) 3 c.c. of acid mercuric nitrate solution (mercury dissolved in twice its weight of nitric acid, and after solution diluted with an equal bulk of water).

The milk, with the addition of water and mercuric nitrate solution, is well shaken, and filtered; a perfectly clear filtrate should be obtained.

This is polarized in a 200-mm. tube, and the reading will give percentages of anhydrous milk sugar.

As an example of the amount of water to be added, if the specific gravity of the milk was 1·0325, the fat 3·6 per cent, and the polariscope was graduated in angular degrees,

$$\begin{aligned} a &= 3{\cdot}25 \text{ c.c.} \\ b &= 4{\cdot}00 \text{ ,,} \\ c &= \underline{10{\cdot}85} \text{ ,,} \\ &\quad 18{\cdot}10 \text{ c.c. of water to 100 c.c.} \end{aligned}$$

50 c.c. of milk were taken, 9·05 c.c. of water, and 1·5 c.c. of acid mercuric nitrate were added.

Proteins are determined by estimating the total nitrogen by the Kjeldahl method, and multiplying the percentage by 6·39.

To carry out the Kjeldahl method 10 grm. of milk are placed in a long-necked, round-bottomed flask, 20 c.c. strong sulphuric acid are added, and a drop of mercury the size of a small pea. This is heated first over a small flame till the water is driven off, and then more strongly till the acid becomes colourless. After cooling, about 100 c.c. of water are added, and after the addition of 100 c.c. of 30-per-cent caustic soda, and 10 c.c. of 10-per-cent sodium sulphide solution, the ammonia formed is distilled off into 10 c.c. of $\frac{N}{2}$ hydrochloric acid; the excess of acid is titrated with $\frac{N}{2}$ caustic soda, using cochineal as indicator. Each c.c. of $\frac{N}{2}$ acid is equivalent to 0·007 grm. of nitrogen. The small figures fur-

nished by a blank experiment are subtracted, and the remainder represents the nitrogen in the milk.

Ash is obtained by igniting the residue of total solids at a barely perceptible red heat. There is no trouble in burning the milk to a white ash, if the skin has been broken as evaporation proceeded; if the total solid residue is flaky, it is best to add a few drops of water, and re-evaporate, so that the solids cling to the bottom of the basin before igniting.

Acidity and Aldehyde Figure.—These two determinations are made together; to 10 c.c. of milk add 0·5 c.c. of a 0·5-per-cent solution of phenolphthalein; titrate with a $\frac{N}{10}$ solution of strontia till a faint pink colour appears. The amount used expressed as cubic centimetres of a normal solution per litre of milk will give the degrees of acidity.

1 c.c. of 40-per-cent formaldehyde solution is now added; this at once discharges the pink colour, and a further addition of strontia is necessary to again render the milk faintly pink. The record quantity of strontia used, less that required by 1 c.c. of formaldehyde, expressed in the same way as the acidity, will give the aldehyde figure. By multiplying this by 0·171 an approximate determination of the proteins can be obtained in a very short time.

[H. D. R.]

Circumstances affecting the Yield and Quality of Milk

1. *Breed of the Cow.*—Within certain limits, each breed of cattle yields a quantity and quality of milk which is fairly constant when large numbers are considered, but which, owing to the want of methodically-kept milk records, and the variations in the individuals composing the breed, can be stated for only one breed of British cattle with any degree of accuracy. At the show of the British Dairy Farmers' Association at London there are fair numbers of the principal breeds exhibited, each of which has its total yield of milk weighed and tested for fat, for a period of forty-eight hours. For the nine years from 1900 to 1908 inclusive, the results are as follows:—

Breed.	Number of Cows on which the computation is based.	Milk per day in lb.	Per cent of Fat.
[1] Shorthorns ...	260	49·0	3·66
Jerseys	165	32·25	5·09
Guernseys ...	57	32·36	4·59
Red Polls ...	74	39·30	3·60
Kerrys	67	31·90	4·10

The averages for other breeds entered at the above show cannot be stated with any degree of accuracy, because hitherto insufficient numbers of those breeds have been exhibited.

The Scottish Milk Records have proved abundantly the capabilities of the Ayrshire breed, and from the records for the seasons 1908 and 1909 the following results may be quoted: The records for 1908 include the period from 1st January to the date of the cows being put to grass, which, according to district, varied from 1st to 15th May. Those for 1909 cover the period from the middle of February to the end of September. In this case the number of herds tested was thirty-six, and all the cows had calved in spring. None of the herds would cease giving milk till about the end of November, and as the milk of the last two months of the lactation is very much richer than that of the first seven or eight months, the average per cent of fat for the period given is less than for the whole lactation, but the weight of milk yielded per day is somewhat higher than it would be for the whole period.

Yield of Milk of Ayrshire Cows

Year.	Number of Samples on which the computation is based.	Milk per day in lb.	Average per cent of Fat.
1908	21,786	26·33	3·58
1909	10,604	26·66	3·62
1909	2,451	26·55	3·70

In both years, what is stated as one sample is in reality two, as each is the milk of one cow for one evening and the following morning, and in every case the whole herd is included. It therefore seems as if the milk of Ayrshires was, practically speaking, identical in composition to that of Shorthorns, Lincoln Reds, and Red Polls. The milk of these breeds apparently contains about ·5 per cent less fat than that of Kerrys, and about 1·5 per cent less than that of Guernseys or Jerseys.

2. *Individuality of the Cow.*—Another important factor in milk production is the individuality of the cow. Indeed we find that each cow differs from its neighbour in the weight of milk which it is capable of producing in a day or a year, in the percentage of fat or other solids in that milk, in the length of time she is likely to continue to give milk, and in the quantity of food which she must consume in order to produce each gallon of milk. Provided the cow is supplied with sufficient food to enable her to do her best, these characteristics will remain unalterable, because they are inherent in her constitution, and while each of them may be developed up to a certain point, it is simply impossible to intensify them beyond that degree by any increase in the quantity or quality of food. For instance, the cow which, with a normal quantity of food, yields 500 gal. of milk during a lactation, cannot by an excessive quantity be induced to give 600, 700, or 800 gal. With the best combination of quantity and quality of foods, and under the best management, she may be enabled to produce her maximum yield, but that maximum is easily reached, and the extra care and attention so bestowed on her will not likely increase the yield more than 5 or 10 per cent. In the same way, a cow

[1] Including pedigree and non-pedigree, and Lincoln Red Shorthorns.

which, on a normal quantity and quality of food, produces, throughout her lactation period, milk of an average of 3·5 per cent of fat, cannot by any excess of food, or by any normal change in its quality, be made to produce milk with 4 per cent of fat.

The length of time the ordinary cow will continue to give a profitable quantity of milk is in great part regulated by the interval which has elapsed since her last calving. If a cow is served with the bull about three months after calving, the probability is that she will calve off and on about the same date as she did the year before; but while some cows will only milk eight months, others will continue to milk for nine months, some for ten, a few for eleven, and an isolated one up to the time she drops her next calf. Although under the best conditions the lactation period may be slightly prolonged, yet neither extra care in management nor additional supplies of food will make the cow which with normal attention only milked eight months continue her milk yield for ten. Some cows have their powers of digestion and their capacity to produce milk so highly developed that the value of the food consumed by them, which is necessary to produce a gallon of milk, is probably not the half that of other animals in the same byre. While judicious feeding may improve to some extent the milk yield of the less profitable animal, yet she will never become so economical of her food as the other, and no amount of spicing or special flavouring of her food will do any good. All such qualities are constitutional and hereditary; they may be bred into a stock, but they cannot be forced into it by any method of feeding.

THE QUALITY OF MILK OF HEAVY MILKERS COMPARED WITH POOR ONES.—There is a common belief that as a rule heavy-milking cows give comparatively poor milk, while poor milkers yield milk of extra good quality. Under this supposition many breeders have continued to keep and breed from cows which yielded a comparatively small quantity of milk of a presumably high quality. An enquiry into the facts of the case would probably have altered both their practice and their opinion in this matter. In the Scottish Milk Records for 1903, 1904, 1905, and 1906, the writer has compared 10 per cent of the most profitable cows with a similar proportion of the least profitable members of every herd. The number of cows on which the comparison is based is fairly large, and each year the results correspond very closely with those of the year before, notwithstanding the fact that different cows and cows in different districts were reported on. From the facts so brought out, it seems as if the general impression was not well founded and is misleading.

Year	Number of Cows on which the average is based	10 per cent of the most profitable Cows		Period of Test in weeks.	10 per cent of the least profitable Cows.	
		Average Milk in gallons.	Average per cent of Fat.		Average Milk in gallons.	Average per cent of Fat
1903	90	545	3·84	26	318	3·50
1904	38	643	3·80	30	396	3·48
1905	44	915	3·89	52	563	3·61
1905	35	635	3·90	34	429	3·68
1906	60	685	3·95	26	423	3·63
Total	267					
Average		663·2	3·88		407·6	3·57
Difference		... ...	... ...	... .	255·6	·31
					663·2	3·88

It is interesting to note that in every year the percentage of fat in the milk of both lots of cows has varied within very narrow limits; and although the figures offer no explanation why the one lot should have richer milk than the other, notwithstanding the much greater yield, yet from the uniformity of the results of each year in the above table, it seems as if the conclusions arrived at were of general application, at least as far as the Ayrshire breed is concerned.

3. *Age of Cow.*—Among dairymen there has always been a great diversity of opinion not only as to the quantity of milk yielded by cows of any particular breed according to their age, but also regarding the quality of the milk of individual cows at different ages. Cows of every breed vary so much in the quantity and quality of their milk that any figures which were obtainable from private sources were very apt to be misleading, while the numbers on which the figures were based were too limited to be reliable. Since, however, the milk records were started in Scotland, reliable data have been placed at our disposal. Yet the number of animals experimented on is still too limited, and only approximate results can be given; but as years go on the numbers will increase, and ultimately become so great that we will be able to say quite definitely what quantity and quality of milk the average Ayrshire cow of any age may reasonably be expected to yield.

The table given at top of p. 16 is compiled from the Milk Records of 1905, 1906, and 1907, in those districts where they were carried on sufficiently long to give a full lactation for the animals tested. In these years every cow, be it good or bad, which had completed its lactation has been included; and as the herds are in no way selected, the results may be looked on as averages at least for cows of the Ayrshire breed.

4. *Period of Lactation.*—There is a very general opinion among persons keeping cows, that milk taken from the cow immediately after calving is much poorer than at any other time in the lactation. On various occasions since the Ayrshire Milk Records were started, tables have

AVERAGE YIELD OF MILK, ACCORDING TO AGE, OF 1265 COWS WHICH HAVE COMPLETED THEIR LACTATIONS, IN THE AYRSHIRE CATTLE MILK RECORD SOCIETIES, UP TO THE END OF THE YEAR 1907

Age of the Cows.	Number on which the average is based	Average Milk in gallons of 10 lb	Average per cent of Fat	Average Milk of 3 per cent of Fat in gallons
2	22	450·6	3·88	582·8
2½	38	495·5	3·89	642·5
3	320	565·8	3·89	730·0
4	189	656·4	3·74	818·3
5	152	721·3	3·65	877·6
6	159	738·7	3·67	903·7
7	127	750·5	3·63	908·1
8	87	774·5	3·64	939·7
9	58	771·1	3·69	948·8
10	46	804·8	3·56	955·0
11	26	819·6	3·62	989·0
12	23	740·0	3·67	905·3
13	9	869·1	3·46	1002·3
15	5	784·4	3·69	964·8
16	3	616·6	3·53	725·5
20	1	878·0	3·70	1073·0

been drawn up, showing for a considerable number of cows the percentage of fat in the milk from the time of calving till the end of the lactation period These distinctly showed that while the general opinion was correct, it was to some extent incorrect as to the exact period The time when the fat content is lowest seems to be not immediately after calving, but four or five weeks later The following table gives the particulars of a considerable number of Ayrshire cows, and in each case the numbers are sufficiently large to give an average which can be relied on with some confidence

THE EFFECT OF LENGTH OF TIME CALVED, ON THE AMOUNT OF FAT IN THE MILK

Length of time calved	Number of Cows reported on	Milk daily in lb	Per cent of Fat in the Milk
Under 1 week	38	26·3	3·75
„ 2 weeks	97	28·9	3·56
„ 4 „	149	31·9	3·23
„ 6 „	208	32·1	3·31
„ 8 „	243	32·0	3·32
„ 10 „	221	32·7	3·34
„ 12 „	175	34·2	3·42
„ 14 „	114	34·1	3·42

The figures in the above table are from various herds in several parishes. The time of testing extended from March to July As is well known, the percentage of fat in milk materially increases from the third month till the end of the lactation

5. *Time of Milking* During recent years there has been considerable difference of opinion regarding the influence which regular and irregular intervals of milking have on the percentage of fat. In the Scottish Milk Records large numbers of cows were milked at almost uniform intervals of twelve hours, and these involve a sufficiently large number of animals to make the results reliable, and they extend over such a length of time, that any influence which individual animals might have on the results are quite obliterated. As the work was carried out during late spring, summer, and early autumn, there were few extremes of temperature or irregularities of weather to materially affect the results.

Year	Number of Cows on which the results are based	Morning Milk, average per cent of Fat	Evening Milk average per cent of Fat.	Period over which the Testing extended
1903	653	3·91	3·98	26 weeks
1904	161	3·40	3·54	12 „
1905	360	3·87	3·97	30 „
Total	1174			
Average		3·83	3·92	
Difference		·09		
		3·92		

While the intervals to which the above table refers were presumed to be uniform, in reality they were not quite so, as there were numerous instances in which the milkers arrived somewhat late in the morning, and so caused that interval to be correspondingly longer than the other In the morning the milkers hurried somewhat more than they did in the evening, so that the probability is that the milking may have been more complete in the evening than in the morning A very trifling inattention to the milking would have caused as great a difference in the percentage of fat as would have existed between the milk of each period If, therefore, these two sources of probable error had been entirely eliminated, the probability is that both lots of milk might have been identical In some herds where the milking was performed with exceptional care, and uniformly at the same hour, there was very little variation in the quality of the milk, and any that did occur was almost negligible Moreover, the smaller percentage of fat was obtained as often in the evening as in the morning

Professor Ingle, of the Yorkshire College, Leeds, reported in the Highland and Agricultural Society's Transactions of 1901 and 1902, something between 700 and 800 analyses of milk in the first year, taken at intervals which were not uniform, the day interval being nine hours and the night one fifteen hours. His and every other person's experience has been, that where there is a wide interval and a short one, the milk is very low in fat after the long interval, and richer in fat after the short one. In many of Ingle's determinations the morning milk showed only from 1·5 to 2·5 per cent of fat, while in that of the evening it ranged from 4·0 to 6·0 per cent of fat. In 1900 the samples were all taken when the cows were in the house and the feeding was under control The following year about 1600 samples were taken when the cows were on pasture, and were receiving in addition 2 lb decorticated cotton cake each per day As on the previous occasion, the cows were milked at intervals of nine and fifteen hours. As in 1900, the milk of the morning was always comparatively low in fat, even although the feeding was varied at times with the object of improving the fat con-

tent. There was some variation in the percentage solids not fat, but these did not differ so much as the percentage fat. It seems, therefore, that if the day is divided into two intervals of unequal length, the per cent of fat in milk may go down after the long interval to a very low point, and rise to a high level after the short interval.

6. *Food (within ordinary limits)* – This is a subject on which carefully carried out experiments do not accord with popular opinion. The ordinary producer of milk believes certain foods and plenty of them will increase the percentage of fat in the milk, while anyone who has carefully and methodically tested the matter has arrived at a different conclusion. The result of years of experimenting and patient observation seems to indicate that, provided food is in sufficient quantity, it may vary considerably in its composition and albuminoid ratio without materially influencing the quantity or quality of the milk. At Newton in 1893, 1894, 1895, 1896, 1897, from four to eight cows were fed for 5 weeks on rations differing widely in their composition, and it seemed that at each change there was almost invariably an increase in the per cent of fat in the milk. This occurred whether the change was from a starchy food to an oily or albuminous one or the reverse. This rise continued for about 14 days, after which it continued to decrease for about 21 days, by which date the quality had returned to what it was originally. In one series of fourteen combinations of foods extending over 70 weeks, the average rate of rise and fall was as follows:

1st Week *Increase* in Fat over the previous week	2nd Week *Increase* in Fat over the previous week	3rd Week *Decrease* in Fat under the previous week	4th Week *Decrease* in Fat under the previous week	5th Week *Decrease* in Fat under the previous week
per cent.	per cent.	per cent.	per cent.	per cent.
·09	·08	·06	·05	·06
Rise = ·17 % of fat		Fall = ·17 % of fat		

During the continuation of these experiments there were slight variations up and down, caused by the introduction of one new cow at the beginning of each change of food, but with that exception the results obtained were uniform and steady.

There seems little doubt that, provided the food is ample and moderately well balanced, it makes little difference, as far as percentage of fat in the milk is concerned, what is the source of the food, provided it is digestible. It also seems probable that if the quantity of food ingredients supplied in the food is less than is required by the animal for the upkeep of the body and production of milk, the animal will take fat from its body for a time, and will continue to produce its ordinary quality of milk. If underfeeding is continued beyond a given point, it seems as if the per cent of fat in the milk would be lowered below the normal, and would be independent of the amount of oil contained in the food. An excess of oil in the food does not necessarily mean that a high percentage of fat in the milk will be obtained, and foods such as young succulent grass and brewers' or distillers' grains, which have the effect of increasing the yield of milk, seem to do so mainly by the addition of water. The amount of fat yielded per day is not materially increased, but being distributed throughout a greater weight of milk, the percentage of fat in the milk is for a time appreciably affected by such foods.

7. *Method of Milking* – Persons expert at milking will, as a rule, take not only more milk from a cow than indifferent milkers, but the quality of the milk will also be better, and the operation of milking will be performed in a much shorter time. Quick milking is therefore generally more efficient than slow milking. Where an efficient milker follows one who is indifferent at the practice, the two will not be able to get the same quantity and quality than if the better milker had done the work alone. Indifferent milking has a strong tendency to cause the cow to go dry earlier than usual. About 1900 Mr Hegelund, a veterinary surgeon of Denmark, introduced a new method of milking, which consisted in massaging and gently stroking downward the different quarters of the udder after the ordinary milking had been completed. This takes a little time, but it conduces to effective milking, and the quantity obtained much more than repays for the time so occupied.

The milking machine has not made the headway expected of it, because many users consider that with cows nearing the end of their lactation the milking is less effective than when performed by hand, and the cows in consequence go dry the sooner. To clear up any doubt in the matter an enquiry into the use of the milking machine was conducted for a period extending from 1st February to 30th September, 1908. A large number of cows in various cheese dairies were selected for the experiment. The strippings taken by hand after the machine were compared with those from a greater number of cows which were hand milked. The following were the results:

838 cows milked by machine averaged 25 lb. strippings, each of 7·7 per cent of fat.
2863 cows milked by hand averaged 63 lb. strippings, each of 6·8 per cent of fat.

Throughout the whole period about two and a half times more fat was found in the strippings of the hand milked cows than in those obtained after the machine, yet during October several of the users gave up the machine and reverted to hand milking, because they considered that their cows were going dry quicker than when hand-milked. This, however, might have been the result of prejudice on their part.

During the period from February to September inclusive, machine and hand milking gave the following results from cows in much the same circumstances but on different farms:

2,451 full-day milkings by machine averaged 26·55 lb of 3·70 per cent of fat per cow.
10,604 full-day milkings by hand averaged 26·66 lb of 3·62 per cent of fat per cow.

If the milk yielded daily by each of these two lots of cows is reduced to pounds of milk of an equivalent of 1 per cent of butter fat, it is easier to make a satisfactory comparison, thus:—

26·55 lb. of milk of 3·70 per cent of fat equals 98·23 lb. of 1 per cent of fat.
26·66 lb. of milk of 3·62 per cent of fat equals 96·50 lb. of 1 per cent of fat.

Looked at, therefore, from the point of view of the yield of butter fat, the cows which were milked by the machine seem to have yielded about 1¾ per cent more fat than those milked by hand. It may of course happen that the herds milked by the machine contained better cows than those milked by hand, but on that point there is no information available.

8. *Temperature.*—The Highland and Agricultural Society have been enquiring into this matter, and a preliminary report issued in the spring of 1908 seemed to indicate that cows reasonably housed do not materially suffer from any colds to which they may be subject in this country, provided that they have not been kept close and warm, and have been allowed to retain the whole of their autumn crop of hair. From the middle of November, 1908, to the end of March, 1909, the milk of 100 cows was weighed and tested for fat twice daily. These cows were all in full milk, and the five farms on which they were located were scattered throughout the South of Scotland, and were situated at altitudes varying from 100 ft. to 720 ft. above the sea level. At each farm an equal number of cows, calved at the same time, and giving the same quantity and quality of milk, were placed in two similar buildings, one of which was kept freely ventilated all winter, and the temperature of which was allowed to fall to the freezing-point, while the other building had the ventilation restricted so as to keep the temperature between 60° F. and 65° F. For the whole winter the freely ventilated buildings had an average temperature, as recorded by the self-registering thermographs placed in each byre, of 49·82° F., while the average temperature of the other byre was 59·40° F. During eighteen weeks the cows in the freely ventilated byre yielded 27·5 lb. milk daily of 3·55 per cent of fat, while those in the warmer byre with restricted ventilation gave 27·3 lb. milk of 3·49 per cent of fat. There was therefore not only no loss of milk from keeping the animals colder than is usual, and having the buildings freely ventilated, but a small gain of ⅕ lb. of milk daily over the whole period. During the period over which the experiment extended, this amounted to about 2 gal. per cow. While trifling for each cow it amounted to 1000 lb., or 100 gal., for the 50 cows to which it applied. In the above experiment the food of both lots of cows was periodically weighed, and as far as possible each lot of animals received exactly the same quantity and quality.

During the continuance of the experiment there were two very sharp falls of the thermometer, which in each case continued for about a week, and during which time the weather was exceptionally severe. During these periods the temperature of the freely ventilated byres fell to the freezing-point, but except on the first day the yield and quality of milk did not seem in any way affected. *At Newton, where there were 18 cows in each building, the cows in the freely ventilated byre produced a total yield per day of 492·7 lb. milk during the mild and warm week which preceded the cold snap, while during the week of severe cold the yield was 495·2 lb. daily. A gain of 2·5 lb. milk was therefore* obtained from 18 cows in the week of cold weather. In the mild weather the average per cent of fat in the milk was 3·73, and during the four coldest days it was 3·61 per cent—a difference in favour of the warm weather of ·12 per cent of fat. The other lot of cows had an almost similar increase in weight of milk, but in their case the fat was increased from 3·61 to 3·65 per cent. In the freely ventilated byre, the temperature for the previous week averaged 54·6° F., and for the four coldest days it was 39·8° F. The other farms at which this experiment was carried out had almost a similar experience. The experiment is being repeated. It is needless to say that the colder but freely ventilated buildings would be much more healthy for the stock than the warmer ones, the air of which was very badly polluted.

9. *Climate and Weather.*—The influence of these may be considered together. It is generally believed that the warmer the climate the more economical is the consumption of food. If, however, a climate is too warm for the comfort of the animal, it will be upset, and sooner or later will become more or less unhealthy, and any results obtained will not be comparable with those recorded under more normal conditions. There is, however, very little definite information on the point, since any experiments which might have thrown some light on the matter were usually complicated by some other circumstance, and on that account the results were indefinite. As far as British farm stock is concerned, temperature alone of weather conditions does not seem a specially important factor in milk production.

It is generally considered that in a cold climate the amount of food necessary to keep up the heat of the body must be somewhat greater than in a warm one, and that therefore less would be available for the production of milk. Where the conditions are identical in all respects save in the matter of temperature, the probability is that this supposition is correct. The variations in temperature in Britain, although more numerous than in most countries, are narrow in range, and on that account a little extra covering of hair in winter seems to reduce to an almost negligible quantity the extra food required then to keep up the heat of the body.

When, however, a low temperature is combined with wet weather (which usually means a wet bed for cattle lying outside), the baneful effects are patent to all stock-owners. To make matters worse, in such weather there is usually very little growth, so that pasture soon becomes bare, and the stock suffer not only from the adverse conditions of the weather, but also from want of food. Where the milk yielded by cows

is regularly weighed, there are considerable variations in the quantity directly traceable to the weather, particularly to bad weather. The quality of the milk also varies; but it does not necessarily follow that because the weather was bad—say wet, stormy, and cold—the quality of the milk will be lower. In many cases during rough periods, although the quantity of milk may be considerably reduced, the per cent of fat may be somewhat increased. It does not seem as if an increased amount of fat is likely to be produced by the cow labouring under the adverse conditions, but rather that much the same quantity is produced, and that in the abnormal conditions it was mixed with a less quantity of the water content of milk. Judging from the speedy effect of the weather on the quantity of milk, compared with the less marked effect on the per cent of fat, the inference naturally drawn from these results is, that the water in milk is more influenced by the weather than the per cent of fat.

If the weather is sufficiently warm to be oppressive to cows, it will cause a reduction in the yield of milk corresponding to what takes place when the weather is very cold. The same happens if cows are in any way disturbed, say by any unusual noise, flies, lice, or vermin of any kind. [J. S.]

Milk, Pasteurization of. See PASTEURIZATION.

Milk, Production and Distribution of. For the profitable production of milk on a dairy farm the primary requisites are a good soil and a favourable climate, and such a combination of soil and climate as will provide abundance of pasturage for summer grazing, and an adequate supply of hay, oats, and roots for winter use. A reliable supply of pure fresh water is also an indispensable factor on all dairy farms.

The other factors which are essential to success in the dairying industry are the suitability of the cow for milk production, and the care and attention which the farmer must bestow on her feeding and management. Undoubtedly the most important of these is the constitution of the cow, which must be naturally adapted for the work. We must regard the cow as a milk making machine for converting the coarser foods of the farm into milk; and the more efficient she is in this respect, the more suitable will she be for our purposes. Experience has taught the dairy farmer, however, that the power of assimilating food and transforming it into milk varies greatly among cows, and that while some give a profitable return in milk for the amount of food supplied, there are many which fail in this respect. The problem that presents itself, therefore, is how to procure good dairy cows; and its solution is to be found in the keeping of reliable milk records, and the breeding from the best milking strains. It need scarcely be added that the constitution of the cow must be sound; she must be healthy, capable of digesting and assimilating a sufficient quantity of food, and well endowed with milk glands in an active and efficient condition.

The management of a dairy herd should be such as will cause the individual members to give the largest yields of milk of which they are physiologically capable, and an important factor in this connection is the food supply. Within certain limits, the more food that is given the better does the cow thrive and the more milk does she yield. But the yield of milk will not continue to increase proportionately with each additional increase in the food supply. A stage is soon reached at which the extra return in milk does not pay for the increased cost in the food supply; and after this point has been passed the additional increments in the milk yield can no longer be profitably obtained. There is for every cow a point of greatest profitableness, and the feeder must decide this limit for himself, being guided by the milking capacity of the cow. Further, the amount of food given should be varied according to the milk yield. The result of feeding experiments gives us some guidance in this respect. It has been demonstrated that a maintenance diet for a dry cow is about 8 or 10 lb. of digestible dry matter per day, and that for a cow in milk about 2 lb more are required for every gallon of milk produced.

For a medium-sized dairy cow—such as an Ayrshire—in full milk in summer, the diet might consist of 112 lb of pasture grass, which she would gather for herself. Grass is by far the cheapest and most suitable food for milk production; and if milk is to be produced at a profit in seasons when grass is not available, an enhanced price must be obtained for the produce. The increased cost for food alone in winter compared with summer is about 3*d.* per gallon of milk. In winter the ration might vary between the following limits:—

Concentrated foods (meals and cakes)	7-10 lb.
'Roots'	20-50 ,,
Fodder (hay and straw)	16-22 ,,

In choosing the ration the dairyman should include as many different kinds of foods as possible, and further, the ration should be well balanced in regard to the nitrogenous constituents (see ALBUMINOID RATIO).

It will be found from experience that the pulping or slicing of roots for dairy cows will not as a rule prove profitable. Exception, however, might be made in the case of a heavy milking cow in winter when milk prices are high. Neither is it advisable to cook any of the foods, except the potatoes. A good method of preparing the food is as follows: Soak all the meals together for several hours in cold or slightly warm water; mix them with the mash, and by adding hot water heat the whole mixture to the body temperature before feeding; give in a sloppy form.

Since the fixing of the legal standard, milk producers have had to pay particular attention to the quality of the milk. Formerly, most practical men were wont to believe that the quality of a cow's milk could to a great extent be regulated by the feeding; but the results of many practical experiments have disproved this, and have shown that if cows are well cared for and fed on a ration which keeps them in good

condition, then a change to an equally suitable or to a more liberal diet will have little or no permanent effect on the quality of the milk. The only way in which we can improve the quality of the milk yield is to select and breed from those cows whose milk is shown by analysis to contain a high percentage of butter fat.

The best results in milk production are to be obtained from dairy cows which have calved more or less recently. From careful observation we learn that a cow is at her best as a milk-making machine shortly after calving. As the lactation period advances, the yield of milk and the return for food decreases. Hence there is little use in attempting to produce milk profitably from cows far gone in lactation. It will pay better to discard these for a time, and to replace them with newly calved cows. At the close of the lactation period—the average length of which is 300 days—the cow should be rested for a time, and brought into condition for her next lactation. It is just when cows are dry previous to calving that this can be most effectually accomplished.

What is the best age for bringing a heifer into the dairy herd? Many practical men believe this to be two or two and a half years, and that heifers calving at such an age will eventually turn out the best dairy cows. Doubtless early calving promotes the fuller development of the mammary glands, and may be practised with advantage if the animals are healthy, well forward, and especially if they come of a strain tending to produce beef rather than milk. But heifers from a good milking strain may with advantage be allowed to become more fully developed before bearing the burdens of maternity.

As a result of careful experiments it has been found that from the period of her first calving up to the end of the seventh year of her age a cow gives increasing returns in proportion to the food consumed. From the eighth year onwards the milk yield decreases, until, when the cow has reached the age of twelve or thirteen years, the return for the food supply may be less than in the case of the milking heifer.

Thorough milking is one of the first principles in milk production. By milking the cow clean we create in her an artificial demand for milk; and nature presuming that milk is wanted by the calf, responds accordingly.

Summing up, then, we see that for the maximum production of milk we require a cow from a good milking strain. Her sire should be a bull also out of a good milking strain, and both should be bred from families whose milking powers have been demonstrated by a system of milk records. The cow should be about seven years old, newly calved, and in good condition at the time of calving. In summer she should be placed on good pasture, where she will have access to a good water supply, and shelter when necessary. She must be thoroughly milked at least twice daily, and she should be milked at regular intervals. Gentle treatment is essential. The winter rations should be liberal and well-balanced.

Distribution of Milk.—Fresh milk is a perishable commodity, and its treatment should be based on this fact. If it is to be marketed as whole milk, it should be despatched as soon as possible after milking, every precaution being taken to ensure its purity and freedom from contamination by germs. By far the greater part of the contamination takes place in the byre or cowhouse during milking. To reduce this to a minimum, attention should be paid to the following points:—

1. The atmosphere of the byre must be kept as free from dust as possible.
2. The cows' coats should be groomed and kept as clean as practicable.
3. The udders should be regularly cleaned with a damp cloth before milking.
4. Those engaged in milking should be clean in person, and must wash their hands in clean water before milking each cow.
5. The first milk drawn from each teat is always highly contaminated with germs and should be rejected.

After being drawn from the cow, the milk should be removed immediately from the byre to a purer atmosphere and sieved as thoroughly as possible. It is usual to pass the milk first through a milk strainer of ordinary brass-wire gauze; it is then more thoroughly strained through a similar sieve covered with three layers of straining cloth which has been previously sterilized by boiling. In addition to these precautions, care should be taken that all the utensils with which the milk comes in contact should be steamed or scalded.

As soon as possible after straining, the milk should be cooled to 60° F. or under. It is found that if milk is reduced to below 60° F. its bacterial content remains practically unchanged for thirty or forty hours. It may be cooled in bulk by immersing the churns in cold water, or in artificially cooled brine where such is obtainable; or it may be cooled by passing it in a thin film over the large surface of the refrigerator; but the latter method exposes the milk to further bacterial contamination.

The milk supply of the smaller towns and villages in this country, and to a certain extent of the larger towns also, is transported from the dairy in large churns (cans), and is measured out to each consumer in the street. In such cases, care has to be taken to keep the contents of the cans well mixed, in order to do justice to each purchaser. Sale of milk in the streets results in considerable contamination, while in very many cases the condition of the milk jug of the purchaser is not such as is conducive to good keeping properties in the milk. The method of delivering milk to order in small covered cans has been largely adopted; but the practice of putting the milk into special bottles on the farm and delivering the bottles intact to the consumer is to be recommended. The milk should be bottled as soon as it has been cooled. The bottles are then sealed with the pulp disks or caps and delivered forthwith to the consumer, or kept in a cold store until required.

Milk well handled and kept at a temperature of about 55° F. should be in good condition sixty hours after it leaves the cow, and there

is no need for the use of preservatives of any kind in our fresh-milk supplies. Pasteurized or sterilized milk may be very useful where a regular supply of fresh milk is not available, but there is no doubt that the dietetic value of the milk and its palatability are both diminished as compared with well-cooled, pure, fresh milk.

Milk may be distributed in various other forms, in which it is in a more or less preserved condition, as condensed milk, buddeised milk, dried milk, or milk powders, &c.; but these preparations are only of use for special purposes, and will never compete successfully with milk in its natural condition. [W. SL.]

Milk, Statistics of.—It is probable that we possess less reliable statistics of the production and consumption of milk in this country than of many other agricultural products. The number of 'cows and heifers in milk or in calf' has been ascertained for more than forty years, and quite lately the British returns show that some four-fifths of these were being milked at the time of the yearly census. But neither as to the average yield per cow nor as to the proportion claimed by the calf are opinions altogether agreed, while there is room also for discussion how much of the available product is consumed in the form of butter, of cheese, and of milk respectively, while there is also a new and smaller proportion of late years manufactured at home into condensed milk. Estimates of production have no doubt been framed from time to time, and calculations made of the varying consumption of milk and milk products by different classes of the community, yielding totals from which, by deduction of the known imports, the native production may be arrived at. In a recent enquiry into this subject by a Committee of the Royal Statistical Society both these methods of investigation were combined. Since the issue of their report in 1903-4, comparatively slight changes have occurred in the imports of butter and cheese and in the number of cows maintained at home, so that the conclusions then reached may be accepted now.

On the basis of an average stock of 4,100,000 cows, and yield of 420 gal. per cow, the Committee put the available supply at 1,723,000,000 gal. of milk; more than half of this, or 944,000,000 gal., being made into butter, 153,000,000 gal. into cheese, and somewhere about 6,000,000 gal. sold as condensed milk. Only 620,000,000 gal. of fresh milk would therefore be left to supply a population of 41,338,000 persons—the average resident population of the years 1899-1903. This would allow about 15 gal. to each person, and such a figure would be in close agreement with the weighted average of many independent estimates of milk consumption, which have, however, ranged from a head rate of no more than 5 gal. in the case of labourers to over 30 gal. among the upper classes. The quantity of fresh milk imported is quite negligible and may be disregarded in such a calculation, as it does not reach $\frac{1}{50}$th part of a gallon per head, and has shown no expansion. The importation of condensed milk—chiefly from Holland—is more considerable. It rose rapidly in the last twelve years of the 19th century to a total of nearly 50,000 tons, but has remained below that figure since 1900; and may be taken to represent about 2¼ lb. per person, of which, however, about 1 lb. per head is re-exported. On the other hand, the milk-consuming population of this country is greater than it was when this report was published by fully three millions and a half, and unless there has been a considerable improvement in the outturn of British dairy herds, or less milk has been turned into butter and cheese—a possibility which is quite feasible in view of the apparent expansion of the milk trade—the consumption would be relatively reduced at the present day. The difficulty which attends any close determination of the milk yield of the country as a whole will be best recognized by a study of the report of the Committee above referred to; and low as the average of 420 gal. per cow may seem to the owners of well-kept herds of dairy cows, it is kept down by the large proportion of poor yields still existing, and by such an average as the 400 gal. that has been attributed to Ireland. The present figure is moreover higher than had been suggested by Mr. Chalmers Morton or Professor Sheldon in the 'seventies and 'eighties, or by Mr. Rew or Mr. Turnbull in the later years of last century. [P. G. C.]

Milk, Sterilization of. See art. STERILIZATION OF MILK.

Milk Fever in Cattle.—This disease is only too well known in dairying districts throughout the British Isles and on the Continent. It is recognized by different names, which vary either according to the locality or the theories held as to its nature. Thus we find the terms 'parturient apoplexy' and 'dropping after calving' sometimes used to signify the condition which is perhaps most widely known under the name 'milk fever'. It is a disease peculiar to cows, occurring only within a few days of parturition (calving), not usually met with in heifers at their first calving, occasionally occurring at the second, and increasingly liable to occur at subsequent calvings. The cows which are most liable to be attacked by this disease are those in good condition which are also good milkers. It may, however, be met more rarely in thin cows and poor milkers.

The symptoms vary according to the suddenness or severity of the attack. Where there is an opportunity of watching a case from its beginning, it is generally found that the early stages of the disease are attended with excitement or uneasiness. A kind of paddling movement with the hind feet is common. In some cases the animal at first alternately lies and rises, while in other cases she persistently stands, until at length, overpowered by the effects of the disease, she falls and is unable to rise. Nervous symptoms, with loss of power to rise, are invariably present for a longer or shorter period during the progress of an attack. In some cases this paralytic condition is accompanied by a tendency to coma, the animal becoming unconscious, breathing stertorously (snoring), having a tendency to throw itself flat on its side; in

which case, unless this be prevented, there will soon be a condition known as tympany of the rumen, *i.e.* distension of the first stomach with gas. In other cases, however, instead of this condition of coma there may be convulsive attacks, *the cow struggling severely, the head being violently dashed about so that the horns are sometimes broken and the eyes injured. In nearly all cases the eyes cease to react to the influence of light, and in severe cases the eyeball can even be touched by the finger of the attendant without causing blinking.* The bowels usually cease to act, and there is retention of urine.

The flow of milk is generally diminished or even suppressed, but this is not invariably the case. The attack usually sets in from a few hours to a few days after the birth of the calf, the severity of the attack being greater if the disease sets in shortly after calving than is the case when the attack is delayed a day or two. Isolated instances are recorded where the disease has set in as late as a fortnight after calving, but the great majority of cases occur within four days of parturition.

Cases have been reported where the disease is said to have occurred before the birth of the calf; but it is not probable that such cases were really due to milk fever, there being a fairly common condition met with in pregnant cows where there is loss of power, but the diagnostic nervous symptoms of milk fever are absent.

The exact pathology of milk fever is still obscure, though great progress has been made during recent years in the matter of its treatment. Its actual cause is not known, but it is generally recognized that the chief predisposing cause is excess of condition in adult cows which are also naturally good milkers.

It is probable that the chief point of attack in this disease is the udder, which statement is confirmed by the success of the modern method of treatment by local applications (injections), which will be fully described later. The symptoms of this disease are by some attributed to the absorption of some deleterious substance formed in the udder during the course of the attack.

Prevention.—Though it is not possible to prevent the occurrence of cases of this disease where dairy herds are selected for their milking qualities and are fed even moderately, yet it is found that certain precautions can be adopted which will diminish the probability of attack, and even if unavailing in this respect, will increase the likelihood of recovery. These precautions consist chiefly of a sparing diet, sufficient exercise, cool housing, or, where possible, outdoor life, stimulation of the natural functions, *i.e.* keeping bowels and kidneys active. Thus if a stock-owner has a cow carrying, say, its third, fourth, or subsequent calf, which cow is known to be a good milker and is in good condition, it will be well to graze her on a poor pasture, where she will get sufficient exercise while picking up her subsistence. If, as is sometimes the case, her gross condition persists, or if the time of calving is too near to admit of this treatment, then it will be well to administer one or more aperient doses, which will have a depletive effect.

Such a dose may well be given from six to ten days before the cow's period of pregnancy is due to terminate; but where there is unusually high condition, or where there has been a previous attack, *it may be well to give one dose at three weeks and another at ten days before the date on which the calf is due, this date being 285 days from the date of the last service.*

The nature of the purge is not very important, castor oil, linseed oil, treacle, sugar, Epsom salts, &c., being each used with success. Oleaginous purges have the advantage of reducing the appetite for a time, and further it is held that repeated doses of oil favour easy parturition. Treacle and sugar are mild and safe aperients, having also the advantage, if given frequently, of facilitating the expulsion of the fœtal membranes (cleanings) after parturition. Epsom salts is perhaps the purge most commonly used, and forms the basis of most of the drenches advertised as preventives of this and some other diseases, but should always be accompanied with ginger and a moderate stimulant. Thus 1 lb. of Epsom salts with 1 oz. of ginger and 1 qt. of warm ale or stout is frequently administered, within a fortnight of calving, with success. Of sugar or treacle about 2 lb. is usually given, and can be repeated at intervals of a few days according to the effect produced, while of oil from 1 to 2 pt. may be given in the same way, the object being to produce moderate laxative action rather than active purgation.

Though milk fever most commonly occurs in the summer months when cows are at grass, yet cases are frequently met with in house-fed cows during winter, and in these cases it is necessary to avoid all stimulating or milk-forcing foods, such as bran mashes, cotton cake, &c., the staple article of diet being hay, with the addition of sufficient roots to keep the bowels active. An aperient dose will be found to be a useful preventive in the case of these in-fed cows also. It is erroneous to suppose that the presence of the calf with its dam will prevent an attack of this disease, even though the calf be allowed to suck the cow from its birth.

Treatment.—The system of treatment of this disease has within recent years undergone a complete revolution, owing to the discovery of Schmidt. Some years ago, acting on the theory of apoplexy, it was the custom of some to practise bleeding, applications to the head, administering of large doses of medicine—the latter in many cases being nearly as dangerous as the disease, owing to the liability of the patient in its comatose or semi-comatose condition to be choked.

Later, a considerable amount of success was obtained by the use of chloral hydrate in comparatively large doses, there being, however, the same objection to this drug of danger from choking, unless the case was attacked in its early stages.

The administration of stimulants and the application of fomentations and blisters along the spine were also sometimes used, and confound-

ing cause with effect, powerful purges were administered to combat the apparent constipation.

Of all these lines of treatment the most successful was the administration of chloral hydrate, and this drug is still used by some practitioners with success.

Though a powerful opiate, it can be given in very large doses to a cow suffering with milk fever, the usual dose being 1 oz. every four hours, some practitioners beginning with even a larger dose and continuing the administration of the ounce doses every four hours until the cow regains consciousness and is able to carry the head. At this period, however, considerable skill and experience are required to judge as to the necessity or otherwise for the administration of stimulants.

As chloral hydrate is somewhat irritating to the throat, it is well when administering it to give some treacle with each dose, which will have a laxative effect after the acute stages of the disease are past, though the administration of purges *per se* is practically useless in the treatment of the disease.

The method at present most generally adopted, and certainly the most successful, is the injection of remedies into the udder itself. It is not necessary to enter into a consideration of the reasons, physiological or otherwise, for this fact. Experience shows that the mortality from milk fever has been enormously reduced since the introduction of this method. The instrument used for the purpose is practically the ordinary rubber enema syringe used in human medicine, to which is attached a long fine nozzle of nickel or some similar metal having apertures near the free end.

This nozzle is sufficiently fine to pass up a cow's teat without force, and is long enough to reach to the milk cistern of the udder. By means of this instrument, whatever remedy is selected can be injected with ease. It is essential that great precautions be taken to keep this instrument absolutely clean and free from contamination, the nozzle being boiled or otherwise thoroughly disinfected before use. If this precaution be neglected, serious results may follow. Before making the injection the milk should be drawn out and the udder thoroughly cleaned and washed with a disinfectant such as dilute Jeyes' fluid, lysol, chinosol, &c.

The substances which have been successfully used as injections are numerous. The substance first used was iodide of potassium, the strength being from 1 to 2 dr. of the drug to 1 qt. of boiled water which has been allowed to cool to blood heat, ½ pt. of this solution being injected up each teat. It has been found, however, that many other substances are also efficacious, some practitioners using lysol, others chinosol, &c., according to the directions given by the manufacturers. The simplest line of treatment is the injection of ordinary atmospheric air, the same instrument being used, though with the addition of a metal chamber, filled with medicated wool, through which the air is drawn. This treatment is usually efficacious, but many practitioners prefer to inject both a drug and the air. When air is used, either singly or in combination with a drug, it is usual to adopt some plan for preventing its escape from the teats, the udder being inflated until fairly distended. The air can be retained; either by patent clips for the teats, which can be bought from the instrument maker who supplies the syringe, or by light pieces of tape, which should be tied on each teat and left on for an hour, being sufficiently tight to retain the air while not injuring the teat. Several instruments are now on the market by means of which pure oxygen gas can be injected into the udder in the same way as air, and this has certainly advantages over any other method. The injections, whatever their nature, very rarely need to be repeated, and may be drawn off after three hours. Good nursing is essential in this disease, the constant presence of an experienced attendant being desirable, and the assistance of several men being occasionally necessary. The patient must be propped upon her chest so as to prevent the distension already mentioned, the head being propped in a natural position pointing forward.

The urine should if necessary be withdrawn by catheter, and the posterior bowel emptied by hand. It may be mentioned that enemata, which are useful in so many diseases of the horse, are of little use in cattle for anatomical reasons.

No attempt should be made to drench an unconscious animal, but in the early stages of the disease the chloral hydrate treatment may be adopted in conjunction with the injections of drugs, air, or oxygen.

When consciousness returns, a small quantity of nourishing drink may be offered at intervals of an hour, and if the animal appears depressed a few glasses of good whisky may be given in a pint of gruel, the latter being strained free of coarse grains, which might irritate the throat and cause coughing or choking.

If, as is sometimes the case, the loss of power remains though the disease itself appears to be cured, and the cow seems apparently healthy, she must be treated for paralysis, and in some cases a considerable time may elapse before recovery takes place.

In such cases, applications to the spine, which are not of service in the acute stages of milk fever, may be used with advantage, any of the ordinary stimulating liniments or embrocations being suitable, or even mustard mixed with vinegar. A full and nourishing diet must now be allowed, a relaxed condition of the bowels being maintained, while as internal remedies, the most powerful nerve tonics must be administered. Of these, nux vomica is the most effectual, generally given in doses of 1 dr. of the powder once or twice per day; but it must be remembered that this is a powerful poison and must be used with extreme caution. Iodide of potassium is sometimes used where effusion on to the spine is suspected, being given in doses of from 1 to 2 dr. twice daily.

Throughout an attack of milk fever, or any condition resulting from it, careful attention must be paid to the cow's bedding, which must be plentiful and dry, the animal being turned

over twice daily when unable to turn herself, as, otherwise, serious bedsores may result, especially if the cow be allowed to lie for any lengthened period on a damp or dirty bed.

In conclusion it may be said that this disease, which was for long the dread of dairy proprietors, is now looked upon as one of those most likely to be cured if treated by a skilful person, the percentage of deaths in the hands of some veterinary practitioners not amounting to 5 per cent of the cases treated.

The number of cases arising can be reduced by attention to the diet of pregnant cows, with the judicious use of aperients.

In order to obtain the best possible chance of success, treatment should begin as early in the attack as possible; but the owner need not give up hope even in cases where, through carelessness or inadvertence, a cow has been allowed to reach the comatose stage before assistance is sought, as, though it will not be then possible to administer medicines by the mouth with safety, the injection into the udder of medicines or air will frequently be efficacious, working most astounding cures. Nursing during the progress of the attack, and careful management after apparent recovery, are in all cases most essential. [F. C. M.]

Milking (by Hand).—No operation on the farm requires more knack and concentration of attention and nervous energy, if it is to be effectively and skilfully accomplished, than the art of milking.

If the cows are housed they should, prior to being milked, be groomed over, and their udders, if not requiring washing, thoroughly rubbed with a clean, dry cloth. This not only prevents hairs and scales from dropping into the milk pail, but encourages the cow to let her milk down into her teats. To ensure the best results in milking, the byre must be kept quiet and the cows gently and kindly treated. The kindlier the treatment and the more expeditious and thorough the operation, the better the results.

Proficiency, however, depends largely on how the milker learns the art; and many who for years were indifferent milkers have become good milkers through getting a lesson or two from an expert. The milker should always speak kindly to the cow before setting down his stool beside her. This keeps her from getting a start, and puts her in good humour. Sitting down, he should catch her fore teats gently with dry hands, and press slowly until she lets her milk into her teats. The fingers should not be put round the teats as is often done, but only three-quarters round, and press the teats with the points of the fingers against the palm of the hand. By catching the teat in this fashion the operator has more power on the milk duct than he has by putting his fingers right round the teat.

When the cow has filled her teats the milker should press more vigorously with an upward pressure on the udder, and, like the calf sucking, never let go his hold, but milk as rapidly as he can until the teats are empty.

Whether the milker gets two, three, or four fingers on the teats will depend on their size; but in any case he should hold on until the end, not relaxing his hold or starting to draw with finger and thumb, after the manner of some, who by so doing finish with a pound or two less milk. A learner finds it difficult to hold on as his unused muscles get sore and cramped, but determination and perseverance in time soon firm the muscles and overcome the strain.

The pressure on the teat should be horizontal, not vertical. Some, at every pressure of the hand, tug the teat downwards as if it was to be drawn off. This is annoying to the cow and hinders the flow of milk. The teat should not be drawn beyond its natural length, and the arm kept so steady all the time that a glass of water might sit on it. The whole operation should be done from the wrist downwards by the action of the fingers and hand.

As the udder empties, the hands should catch upwards, enclosing more of the udder, until the last drop is drawn. The fore quarters should always be milked first, otherwise the cow is apt to become light of her fore quarters, which hurts her appearance and depreciates her value.

Expeditious and clean milking are essentials to success. We have seen a cow giving over 30 lb. of milk milked absolutely dry inside five minutes, and we have seen another supposed good milker sit twelve minutes at the same cow the next day and only get 26 lb. at each milking.

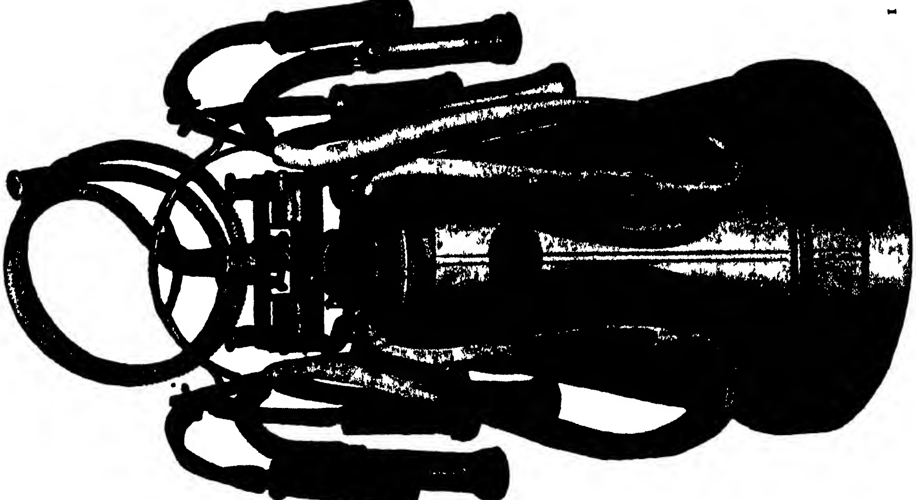
A special method of milking, known as the Hegelund system, got its name from its introducer, a Danish veterinary surgeon, who has been engaged by the Danish Government to teach his system at the various agricultural colleges in Denmark. It is claimed for this system that more milk and richer milk is got than by the ordinary method. As we have seen it practised by Professor Hegelund the method of milking a cow was, generally speaking, as described above until the cow is milked dry, when he proceeds to manipulate the udder somewhat after the following manner:—

1. The right quarters of the udder are pressed against each other, with the left hand on the hind quarter and the right hand in front of the fore quarter, the thumbs being placed on the outside of the udder, and the four fingers between the two divisions of the udder. The hands are now pressed toward each other and at the same time lifted towards the body of the cow. This pressing and lifting is repeated three times. The milk collected in the milk ducts is then drawn out, and the manipulation repeated until no more milk is obtained in this way, when the left quarters are treated in a similar manner.

2. The glands are pressed together from the side. The fore quarters are milked each by itself by placing one hand with fingers spread on the outside of the quarter, and the other hand in the division between the right and left quarters; the hands are pressed against each other, and the teat then milked.

When no more milk is obtained by this manipulation the hind quarters are milked by placing a hand on the outside of each quarter, likewise with fingers spread and turned upward, but with the thumb just in front of the hind quarter. The hands are lifted, and grasp into the

2 Wallace Milking Machine, with cups in milking position
In this machine there is an Atmospheric Motor at the end of each cup.



1 Laurence-Kennedy Milking Machine, with Pulsator on top of Can.

gland from behind and from the side, after which they are lowered to draw the milk. The manipulation is repeated till no more milk is obtained.

3. The fore teats are grasped with partly closed hands and lifted with a push towards the body of the cow both at the same time, by which method the glands are pressed between the hands and the cow's body; the milk is drawn after each three pushes. When the fore teats are emptied, the hind ones are treated in a similar manner.

If the cow has been cleverly milked, only about one teacupful more will be obtained; but if she has only been moderately or even averagely milked, 1 to 3 lb. may be procured by the treatment. Whether or not the method is worth adopting in stripping the cows, will depend on the efficiency of the milkers.

In Denmark, Sweden, and Norway, where labour is cheap, the method is considerably practised, and it is also taught in some of the American agricultural colleges.

In conclusion it may be said that interested expert milkers may be worth twice their wage more than others. If a cow is trifled with, she will take up some of her milk, and no amount of stripping will get it back. Clean milking not only gives you all the rich milk, but it develops the udder, and thus increases the flow of milk. The milk glands in the udder, like the blacksmith's arms, are developed by work. If the milk glands are not thoroughly emptied they are not stimulated but become inactive, and gradually produce less and less, and the cow begins to take on beef. But if the milk glands are thoroughly emptied they are stimulated to produce more and more milk, and the milking properties of the animal are developed. This we think is more especially the case with heifers and young cows whose milk-secreting organs are in process of development. To prevent sore teats, newly calved heifers and cows with hard, swelled udders should, after milking, have their teats washed and dried, and rubbed with vaseline. See also MILKING MACHINES. [J. D.]

Milking Machines.—Attention was first given to substitutes for hand milkers early in last century—at least American records of such date back to 1819. Yet it was about 1840 or later, before ideas in this connection took practical shape. In this country, individual inventors were interesting themselves in milking machines quite as early as in America; but little was done in either country for a long time—indeed the practical difficulties seemed altogether insurmountable.

Probably the first mechanical contrivance for milking cows appeared in New York, in the shape of milk tubes to be inserted into the teats. Later, different types of tubes were employed; but this method of milking was subsequently given up as impracticable.

Soon after the introduction of the milking tubes an attempt was made along different lines, by use of a mechanical device which applied pressure to the teats much as in hand milking. The inventor was an American, Mr. Mayor. The first pressure machine was followed in a few years by another, a modification on the same principle; and during the next twenty years pressure *milking machines were brought forward in considerable variety in America, Germany, Denmark, and Sweden; but most of these were too complicated for ordinary use; and it was ultimately generally agreed that mechanical pressure alone was unlikely ever to become a successful substitute for the action of the human hand* in the milking of cows.

The idea of pressure was abandoned by American workers in favour of suction, or a combination of pressure and suction. Suction milking machines were tried in 1878, and though not successful as introduced, these have led up to the valuable milking machines of to-day which embody the same principle. The suction machines were improved in many respects in America, and a certain measure of success there gained.

It was at this period in the history of milking machines that Scottish inventors began to take the lead. Scotsmen went to work to improve on the American method, on the assumption that the natural method of the calf was the correct one; and from that time the credit of evolving the modern milking machine belongs almost entirely to Scotland.

Probably the first Scottish milking machine was that patented in 1889 by Mr. Murchland of Kilmarnock, Ayrshire. This was followed in 1891 by a machine of a different type, the invention of Messrs. Gray and Nicholson of Stranraer. In both these machines the acting principle was suction without intermission. By this means milk could be removed successfully and even expeditiously; but the great defect was the tendency of the constant suction to interfere with the blood circulation and to produce a congestion in the teats and udders.

Attempts were being made by the inventors to remedy this defect, when Dr. Shields, of Glasgow, superseded them with his milking machine of 1895. Dr. Shields patented a machine which embodied a system of pulsation—intermittent suction and release, and which was known in this country and abroad as the 'Thistle Mechanical Milking Machine'. This machine could remove the milk from a cow effectively; yet after extended trials it did not gain favour among dairy farmers, on account of several objections in the practical working. All the moving parts were driven directly by mechanical power, and the pulsator had to be placed quite near the power source and connected to the cow stalls by a long range of tubing, entailing great waste of power. It was found impossible to keep the milk tubing reasonably clean; large volumes of air had to be passed through the tubes to release suction and give pulsation, causing contamination of the milk, and adding greatly to the cost of maintaining the vacuum. The cost of the machine was practically prohibitive. For these and other reasons the company, having expended its capital, ceased operations.

One of the directors of the 'Thistle' Company, Mr. Kennedy, of Glasgow, and Mr. Lawrence, a Glasgow engineer, continued to apply themselves to the subject, and their united labours produced the now well-known Lawrence-Kennedy Universal Cow Milker. By applying a new principle, that of producing the pulsation near to

the cows themselves by a small vacuum-driven motor on top of the milk pail situated between the two cows, they at once overcame nearly all the difficulties which confronted previous experimenters with intermittent-suction machines, and secured to Scotland the credit of producing the first really practical milking machine.

Another Scottish machine was placed on the market in 1907 by Messrs. Wallace, of Castle-Douglas, Kirkcudbrightshire. This works on much the same principles as the Lawrence-Kennedy machine, but instead of one small pulsator on each milk pail for milking two cows simultaneously, it has a tiny motor fitted to the bottom of each teat cup. The machine has more moving parts and is more delicate in construction, but those who have had extended experience with it speak highly in its favour.

The milking machines at present in use are similar in many respects. The acting force is obtained from a difference in atmospheric pressure, popularly termed 'suction', induced by use of an air pump or other air-exhausting apparatus. The pressure obtained in this way must always be less than that due to a column of mercury 30 in. high, which is about the highest atmospheric pressure, but half this pressure has been found sufficient for purposes of cow milking. A partial vacuum of from 15 to 16 in. of mercury is created in a small air-tight reservoir. Vacuum pipes lead to the cow stalls, with a stopcock or valve for each double stall. To these stopcocks are connected, by flexible rubber tubing, the small portable cow milkers or milking machines. In one of the commoner types, each machine is adapted to milk two cows simultaneously. It fits on to the top of a special milk pail placed between the cows. The machine is operated, held securely attached to the pail, and the latter almost hermetically sealed, by the action of the vacuum. The milker is connected by flexible rubber tubing to each of eight teat cups, which fit on to the teats of the two cows.

The force effecting removal of the milk from the udder is due to difference in pressure. The pressure on the milk inside the udder is atmospheric pressure, and equal to about 30 in. of mercury. The duct of the teat is in direct communication, through closed rubber tubing, with a partial vacuum inside the milk can of about 15 in. of mercury. The milk is thus caused to flow from the udder in a thin stream through the teat and rubber tubing to the interior of the milk pail. In some of the earlier machines, as already mentioned, this action was continuous, and the milk was removed in a continuous stream. The constant suction was found to interfere in many cases with the circulation of blood in the teat and to lead to serious injury. In the more recent machines there is an intermittent action on the teat cup, whereby a pulsation is produced very similar in its effects to the sucking of the calf. Pressure on the teats is relaxed with every pulsation of the machine, and the natural blood circulation through the teat maintained.

The machine working on this principle which is probably in most general use at the present time in this country and abroad, is the *Lawrence-Kennedy milking machine. Machines of this type have been in operation since 1903, and have been thoroughly tested in practice. Most of* the other machines at present in use are modifications of this type, and will be readily understood from inspection, after a knowledge of this machine has been gained. The most recent and perhaps simplest type is known as the Burrell-Lawrence-Kennedy milking machine. An installation of this machine consists essentially of a continuous vacuum-producing or air-exhausting apparatus of a simple form; a vacuum storage reservoir and gauge; the necessary piping, which runs throughout the length of the byre, with a tap or valve for each double stall; and the machines, each of which consists of the small portable apparatus, termed a 'pulsator', placed on the top of a specially constructed milk pail, which it seals almost hermetically by action of the partial vacuum produced. Attached to the pulsator, which is adapted to milk two cows simultaneously, are three flexible and removable rubber tubes, one connecting with the vacuum pipe overhead, and the other two communicating with the eight teat cups.

The vacuum is produced either by steam ejector or by air pump. The latter is preferable, and may be driven by any form of power already available on the farm—steam, oil, gas, water, or horse; not more than 2 horse-power being required, except in the case of specially large installations. In at least one case a milking machine is operated by vacuum produced by the discharge of a volume of water from a close reservoir.

The special part of the whole plant is the little pulsator covering the milk pail. It is here that inventive powers have been specially applied, in order to produce the above-mentioned pulsating effect on the teats. The intermittent action is obtained by regularly cutting off and renewing communication between the partial vacuum in the interior of the milk can on the one hand, and the interior of the milk tubes and teat cups on the other. This communication is made and cut off alternately at frequent and regular intervals by a small moving piston valve. At the instant when the communication is broken off by the moving piston, air is admitted through an opening in the piston itself to the interior of the milk tubes and teat cups. The partial vacuum there is almost entirely destroyed, and the sucking effect on the teat removed.

This piston valve moves inside a small cylinder, and is actuated by power of vacuum. The pulsator on top of each milk pail forms a small vacuum-driven motor. The number of strokes per minute, or frequency of pulsation, is regulated by adjusting the vacuum supply to the dome on the top of the motor cylinder, much in the same way as the supply of steam to a steam engine. A frequency of 45 to 50 strokes per minute is found in practice to give the best results.

The teat cups of this machine are of tinned copper, and are provided with elastic rubber rings or mouthpieces where they grip the teat, nearest to the udder. Cups can be obtained of

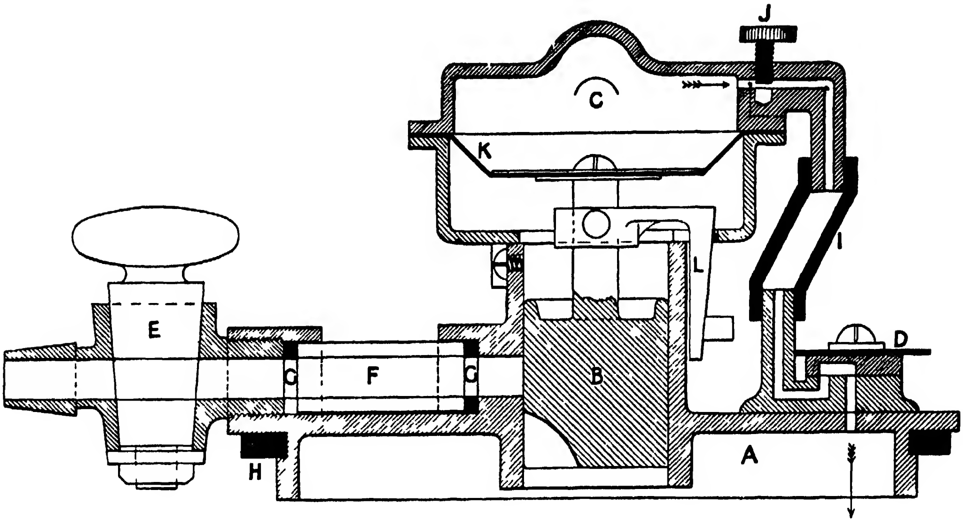


Fig. 1

Piston at Beginning of Up Stroke Valve Ports open to Vacuum

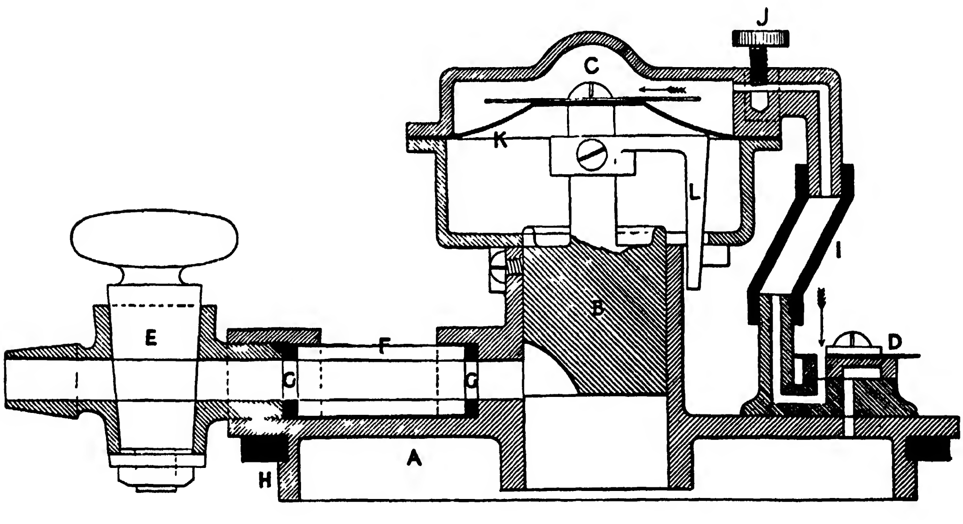


Fig. 2

Piston at Beginning of Down Stroke Valve Ports open to Atmosphere

A, Base Plate; B, Piston, C, Dome Cylinder, D, Valve; E, Milk Cock;
F, Inspection Glass; G, H, Rubber Rings, I, Rubber Tube;
J, Regulating Screw; K, Leather Diaphragm; L, Crank Actuating Valve

DIAGRAMS SHOWING INTERNAL CONSTRUCTION AND WORKING OF THE BURRELL-LAWRENCE-KENNEDY PULSATOR

various sizes, and it is most important for the successful working of this machine that cups be used of the proper size to support the teat at the sides and yet not compress it. The rubber mouthpiece used should be just sufficiently close to prevent leakage of air; the cups will then be held in position by the vacuum action. If they should show a tendency to fall, a supporting belt may be used.

The air admitted to the milk tubes through the action of the pulsator is first filtered from dust and germs through absorbent cotton wool. A further small supply of air is constantly admitted through a small opening in the milk tube, just where the branch tubes from each of the four teat cups converge into the one tube leading to the milk pail. The air admitted here is necessary to allow the milk to flow freely along the tubes. It is likewise filtered through cotton wool. The air admitted is found to have a beneficial effect on the milk.

When the vacuum is in order, the milkers can be very soon set to work. The milk pail with its pulsator on top is placed between the pair of cows to be milked, and the pulsator connected by means of the rubber tube to the stopcock of the vacuum pipe above. When the tap is opened the pulsator begins to work. The speed is regulated so that the piston makes about 45 strokes per minute. The four teat cups are taken in the hand and bent over to close each branch tube, and the stopcock of the milk tube opened. The cups are applied one by one to the teats, and each tube released in turn so as to allow the vacuum to act on the teat. The milk can now be observed, through the short glass tube provided, to run in an intermittent stream from the teat to the pail. When the flow of milk begins to diminish, near the completion of the milking, the teats and udder are gently manipulated by hand. This manipulation, as well as hand-stripping after each milking, is necessary if the best results are to be obtained.

The operation of milking a cow by the machine occupies from four to seven minutes, after which the milk tap is closed and the cups removed. Suction, continued after the milk has ceased to flow, does not injure the animal, as the vacuum employed is a safe one in this respect. On the completion of the milking of the two cows the vacuum tap is closed and the apparatus removed.

In every case, before the teat cups are applied to the cow, the udder and teats should be thoroughly cleaned with lukewarm water, and the teats should always be dry before the cups are applied. Before milking, the teats should first be drawn by hand, and the first milk rejected as likely to cause contamination.

The machine removes the milk as effectively as, and more rapidly and steadily than, the average hand milker. The amount of strippings remaining after machine milking is on the average not greater, and with young cows accustomed to machine milking from the first may be even less, than where hand milking is practised. The animals take to the machine very kindly, and stand chewing the cud, quite at ease, after becoming accustomed to the sight of the apparatus beside them. They seem to be less disturbed by the machine than with an ordinary staff of hand milkers.

The speed of working depends upon the number of pulsators and milk pails employed, and this is at the option of the user. One pulsator milks two cows in an average of seven minutes. With the help of a boy to carry the milk and attend to the engine, one active person can manipulate four machines so as to milk from forty to sixty cows per hour. By the addition of pulsators and pails, the capacity of the installation can at any time be increased if sufficient vacuum is provided.

The machines are comparatively simple in action and do not go readily wrong, while the more delicate parts are quickly replaceable. The chief obstacle to their more general adoption is the heavy initial cost; yet the outlay would be repaid in a comparatively short time by the saving in labour alone. The use of a milking machine is a much less laborious method of milking. Hand milkers are, as a rule, poorly paid, are difficult to obtain, and are too often incompetent. The employment of a few skilful and well-paid hands with a machine would seem to be a more reliable and satisfactory system of milking.

In machine milking very strict attention to cleanliness is imperative, as without this precaution the next-drawn milk would be much worse as regards purity and keeping properties than ordinary hand-drawn milk. With the later machines there is less difficulty in cleaning and keeping in free working order. As soon as the milking has been completed, and before the milk has had time to dry in the tubes, the pulsator is connected to a vacuum tap, and cold water and air are drawn through the parts alternately. This is effected by holding the teat cups entirely under, then quite out of the water. The operation is repeated until all traces of milk have been removed, when hot water is drawn through in a similar manner. To obtain milk as free as possible from bacteria, fresh cotton-wool air filters are inserted for each milking, and special precautions taken in cleaning the machine and the teats of the animals, while the rubber parts, when not in use, are kept in a 10-per-cent brine solution.

Quicker and more thorough removal of milk causes an animal to yield the milk more freely, stimulates milk secretion, and prolongs the lactation period. Where the improved milking machines have been intelligently used for a few years it is found that both the total yield and the quality of the milk have slightly improved, while no injurious effects have been noticed in the cows. Cases of 'weed' or garget have been fewer, owing probably to the more uniform milking out of the udders. The machine has been found specially useful, as compared with hand milkers, in milking small or sore teats.

When the sanitary aspect is considered, there is strong evidence in favour of milking by machine. The possibility of contamination is greatly reduced. The milk is conveyed in closed ducts from the interior of the udder to the sealed milk pail; all dust particles are excluded. Any air

admitted to the milk is filtered free from germs. Under ordinary conditions the sediment found in machine-drawn milk is less than one-tenth of that found in hand-drawn milk. By taking special precautions, machine-drawn milk can be obtained almost perfectly clean and practically free from germs, and it constitutes a superior article and deserves to command a higher price. [W. St.]

Milk Products.—In addition to butter and cheese, which are treated of elsewhere, a number of products are prepared from milk.

These may be classified as:—

1. *Products prepared by evaporation*—condensed milk, dried milk, milk sugar.
2. *Products prepared by the modification of the composition*—humanized milk, peptonized milk.
3. *Products prepared by the action of micro-organisms*—koumiss, kefir, mazoum, lactor.
4. *Products consisting essentially of proteins*—casein and its modifications.

1. Products prepared by Evaporation.—Condensed milk is prepared by heating milk to about 180° F. and gradually drawing it into a vacuum pan which is connected with a condenser. No heat is applied till all the milk is drawn into the pan, and the gases are drawn off; when this is accomplished, steam is turned on, and the milk is evaporated at a low temperature till a suitable consistency is reached.

Cane sugar in the proportion of about 1¼ lb. to the gallon of milk is frequently added, and both whole milk and skim milk are condensed. The sweetened condensed milks are usually concentrated to nearly one-quarter of the volume of the original milk, or to about one-third of the weight. They are not sterilized after concentration, but are filled, after cooling, direct into tins, which are at once hermetically sealed. If properly handled, the number of micro-organisms in the finished product is not large, and, owing to the great condensation, the condensed milks will keep almost indefinitely. The milk sugar to a great extent crystallizes out, and the proper cooling after evaporation is important, as this leads to the formation of very minute crystals distributed throughout the mass. Carelessness at this stage leads to the formation of larger crystals, which make the milk gritty.

Unsweetened condensed milk is not usually concentrated to quite the same degree, about one-third of the volume being as a rule attained. This is done because it is necessary to sterilize the milk after condensation for keeping purposes, and if too highly concentrated the milk becomes semi-solid.

There are various methods of preparing dried milk. The milk is dried, either with or without a preliminary concentration *in vacuo*, and usually with the addition of small quantities of alkali, on heated rollers, which are sometimes enclosed in a vacuum chamber, on trays in thin layers usually *in vacuo*, in a vacuum vessel in which revolving arms keep the milk stirred during drying, or in the form of fine spray. Milk powders if properly prepared keep well, though there is usually a tendency for the fat in the milk to alter in smell and taste and become 'tallowy' or even rancid.

Milk sugar is made by evaporating whey, clarified by boiling and treatment with alum or other substances, to a small bulk. On cooling, especially if kept stirred, the milk sugar crystallizes out, and is purified by re-solution and re-crystallization.

2. Products prepared by the Modification of the Composition.—Humanized milk, or milk for infant feeding, is made in a variety of ways. The aim of all of the methods is to reduce the casein and increase the milk sugar, to make the composition approximate to that of human milk.

The methods are very numerous, and may be divided into four classes:—

(*a*) Simple dilution with water, and the addition of cream and sugar.

(*b*) The removal of casein, and the addition of sugar and, if necessary, cream.

(*c*) The action on milk of a proteolytic enzyme, with or without dilution and the addition of cream and sugar.

(*d*) The addition of a preparation containing diastase, together with dilution and the addition of cream and sugar.

Generally the sugar added is milk sugar, but cane sugar, maltose, and other products from the alteration of starch are sometimes used.

Peptonized milk is prepared by adding a pancreatic extract to milk, usually made slightly alkaline, and allowing it to act till the proteins are partially digested. The further action is stopped by boiling when the required point is reached.

It is essential that the pancreatic extract be fairly fresh, as when old the digesting power is greatly weakened, and the milk curdles when boiled.

3. Products prepared by the Action of Micro-organisms.—Koumiss is a product of the combined alcoholic and lactic fermentation of milk. It was originally prepared from mare's milk, but cow's milk modified in composition to resemble mare's milk is now used. As the fermentation proceeds the amount of alcohol and carbonic acid gradually increase; the casein is precipitated in finely divided flakes, and is partly digested. It has the valuable property of being both a food and a stimulant, and can therefore be retained when other foods are rejected. It has three distinct stages:—

(*a*) The fresh; when it is still, faintly acid, and somewhat laxative.

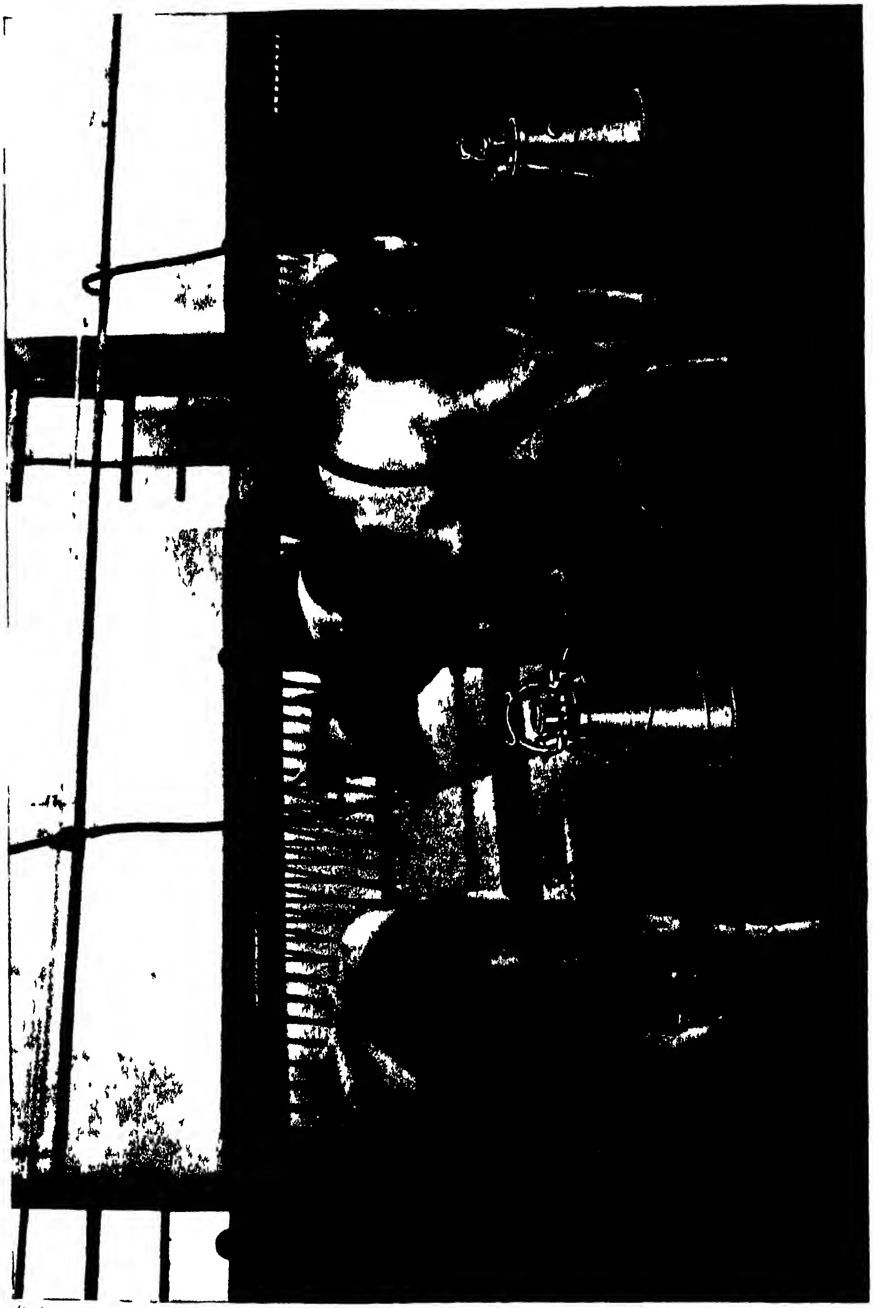
(*b*) The sparkling; the amount of carbonic acid causes it to effervesce, and a champagne tap is necessary to draw it from the bottle.

(*c*) The old; very acid, and somewhat astringent.

Kefir is a product similar to koumiss. It is produced by the action of the specific organisms of kefir grains on whole milk. There is also a combined alcoholic and lactic fermentation, but the amount of gas developed is less than in koumiss.

Mazoum or Youghot is milk concentrated to about half its bulk, and soured by the action of micro-organisms.

Lactor is a product of the action of lactic organisms on milk; it has many names, according to the particular organism used to turn it sour.



BURRELL-LAWRENCE-KENNEDY MILKING MACHINE IN OPERATION

4. Products consisting essentially of Proteins.—Casein is prepared by curdling milk with an acid. The curd is washed, dissolved up in as small a quantity of soda as possible, and reprecipitated by acid. This is usually dried, or it may be dissolved up in a small amount of soda or other alkali, and the solution evaporated to dryness. In this form it is soluble in water, and is sometimes called milk albumin, nutrose, and other names.

If dissolved in ammonia and evaporated, the ammonia passes off on drying, and the casein is insoluble in water.

Plasmon, Tilia, and other names are applied to casein which has been precipitated and dissolved up in alkali, and which contains a large proportion of the original salts of milk.

Eucasin is the ammonia compound of casein, and argonium is the silver caseinate.

Lactoform is casein precipitated by metallic salts and hardened by formaldehyde. It forms a very hard substance which can be polished, and takes the place of horn, ivory, &c.

[H. D. R.]

Milk Records.—The aim of milk records is twofold: (1) To supply an accurate record of the weight of milk yielded by the individual members of a herd; (2) to record the percentage of butter fat in the milk of each cow. The keeping of milk records by the system of weighing or measuring each cow's milk has long been in vogue, but the estimation of the butter fat by the old methods proved too costly to justify its general adoption. Fortunately the introduction of the Babcock Milk Tester (see Milk Testers) solved this difficulty, and nowadays the recording of the quality of the milk forms an integral part in all schemes of milk records.

It has been a matter of common knowledge among past generations that the milking properties of an animal are strongly hereditary, and intelligent dairymen all over the world, recognizing this fact, have invariably selected for breeding purposes those animals which they considered yielded the largest quantity of milk. But with their limited knowledge and primitive methods, few breeders were able to identify those cows which gave the most milk, far less those which yielded milk of the richest quality. The method commonly adopted was to select for breeding purposes those animals which at the time were considered to show the best indications of being heavy milkers. Cows with large udders were usually chosen; but this alone has proved to be a faulty basis for selection, since a cow with a large udder does not always turn out even an average milker.

The present system of taking milk records originated in Vejen, a small parish in that part of Denmark known as Jutland. In the year 1895 it occurred to several farmers in that district that they might derive all the benefits of a milk-record scheme if they conducted the system on a co-operative basis. Twelve of them therefore formed a small society, and engaged the services of an expert, whose duty it was to visit the various farms in rotation and ascertain the weight and the percentage of butter fat of each cow's milk. Once a fortnight each farm was visited, and the milk of the individual cows tested morning and night. From such a small beginning this system spread rapidly over Denmark, Sweden, Norway, and Holland. At the present time there are over 400 milk-record societies in Denmark, and several hundred in the other countries referred to. Mention of the fact should be made, that these fortnightly tests show a trifling variation as compared with the daily tests; still, although the daily testing is the more accurate method, the fortnightly testing is quite reliable for all practical purposes and costs very much less.

In 1903 a similar system was adopted in Scotland. In that year the Highland and Agricultural Society, at the suggestion of the writer, instituted three milk-record societies, one in the county of Ayr, another in Dumfries, and a third in Wigtown. Practically all the expense was borne by the Society, which set aside for this purpose a sum of £200. Each farmer who took part in this scheme fed and lodged the expert when at the farm, and as soon as his work was finished, conveyed him and his outfit to the next farm in rotation. The work began during the first week in May and was continued for six months. The milk from most of the herds tested was devoted to cheesemaking, and as the majority of the cows had been calved from one to three months when the work began, a large number of them were beginning to go dry when it ceased. Although nothing like a full record was obtained for any of the cows, still sufficient was done to show the value of the work. In the words of the report, 'the object sought for, and the main aim of the scheme, was to obtain a means of comparing cows of the same herd, calving at or near the same time, going on the same pasture, and subjected to the same climatic conditions, rather than to compare one herd with another'. During the season, 1342 cows had their milk weighed and tested for butter fat for a shorter or longer period, the details being published in the Transactions of the Society for 1904.

In 1904 the only society that made application for a grant was the Ayrshire Agricultural Association, which had supervised the local society in that county the year before. Under its auspices 389 cows were tested at intervals of 14 days and over a period of 30 weeks, dating from the last week in April.

In 1905 there were two societies at work. The one under the auspices of the Ayrshire Agricultural Association was confined principally to farms in the parishes of Cumnock and Ochiltree. It started on 1st April, and visits were made to each farm every 14 days, and the testing continued for 34 weeks.

Another society, formed in the parish of Fenwick, started operations at the New Year, the district being principally devoted to the production of milk for the city of Glasgow. The visits of the expert for this society were made every 21 days, and during the year there were 443 cows tested for it, and 372 for the Cumnock society, or a total of 815 cows for the year.

During 1906 there were five societies at work, and for them there were tested 2688 cows distributed as follows:—

Cumnock	12 herds, containing	353 cows, every	14 days for	38 weeks.
Dumfries	22 ,,	742 ,,	28 ,,	32 ,,
Fenwick	18 ,,	455 ,,	21 ,,	51 ,,
Wigtownshire	12 ,,	537 ,,	14 ,,	26 ,,
Stewartry	12 ,,	601 ,,	21 ,,	34 ,,
	76 herds.	2688 cows.		

In 1907 the following societies were at work:—

Cumnock	18 herds, containing	530 cows, every	21 days for	38 weeks.
Fenwick	18 ,,	548 ,,	21 ,,	52 ,,
Rowallan	18 ,,	495 ,,	21 ,,	43 ,,
Lesmahagow	14 ,,	398 ,,	21 ,,	43 ,,
Kirkcudbright	12 ,,	431 ,,	14 ,,	31 ,,
Stewartry	17 ,,	969 ,,	21 ,,	28 ,,
Wigtownshire	12 ,,	560 ,,	14 ,,	26 ,,
	109 herds.	3931 cows.		

In 1908 the number of societies had increased to thirteen, and the number of cows to 8132. In this year one society was started in England near Preston, in Lancashire.

In 1909 there were also thirteen societies, mostly in the same districts as before, with the exception of one new society in the island of Bute, and two in the parish of Fenwick merged into one. The number of cows tested is not yet known, but is believed to be about 10,000.

The parish of Vejen, in Jutland, Denmark, where the first milk-record society was started on co-operative lines, affords a good example of the advantages likely to be obtained from a methodical pursuance of the system of milk records. This society was formed in 1895, and the average yield of milk per cow for the first two years was 670 gal., of 3·30 per cent of fat, whereas eight years afterwards the average was 730 gal., of 3·42 per cent of fat. On one farm each cow in 1895 had an average yield of 477 gal. of milk, of 3·35 per cent of fat, which in eight years afterwards was raised to 550 gal., of 3·43 per cent of fat. Another farm had in 1895 an average of 617 gal., of 3·00 per cent of fat, which in eight years was raised to 867 gal., of 3·37 per cent of fat. On other nine farms the average yield per cow between the years 1897 and 1903 was increased by 101 gal. of milk.

Similar increases have also been obtained in Holland. Mr. Kuperus, Marssum, Friesland, began testing in 1897, and his average for 287 days of that year was 923 gal. of milk, of 3·15 per cent of fat. In 1905 his average for 332 days was 1100 gal. of milk, of 3·52 per cent of fat. Friesland cows are proverbial for giving milk low in fat, and this herd prior to 1897 was much the same as others. The increased percentage of fat obtained in a limited period in the milk of this herd is so great that it is worth recording in detail.

In 1897	the total yield of milk averaged	3·15 % of fat.
,, 1898	,, ,, ,,	3·28 ,,
,, 1899	,, ,, ,,	3·39 ,,
,, 1900	,, ,, ,,	3·46 ,,
,, 1901	,, ,, ,,	3·47 ,,
,, 1902	,, ,, ,,	3·44 ,,
,, 1903	,, ,, ,,	3·50 ,,
,, 1904	,, ,, ,,	3·52 ,,
,, 1905	,, ,, ,,	3·52 ,,

In Sweden much the same results have been obtained as in Denmark and Holland. A farmer there, who prided himself on having an extra good herd, began testing in 1897, and for that year his average for 70 cows was 800 gal. He sold 42 of the poorest milkers and kept 28 of the best, which he mated with a bull out of a good milking family. In 1905 he had 72 cows all descended from the 28 animals selected in 1897, and their average yield of milk for that year was 1220 gal.

Canada has also taken up this work very enthusiastically, and under the supervision of the Minister of Agriculture great progress is being made. It has, however, not yet been carried on for such a number of years that much gain has been obtained in breeding, the most of the advantage yet obtained being confined to the rejection of the poor milkers. [J. S.]

Milk Shop Enactments. See Dairies, Cowsheds, and Milk Shops.

Milk Sugar. See arts. Milk, Milk Products, and Sugars.

Milk Testers and Milk Testing.—The approximate percentage of fat in milk and milk products may be tested by the Babcock centrifugal method. This is the pioneer of the centrifugal methods chiefly employed at the present day. 17·5 cubic centimetres—18 grm.—of milk are introduced into a special test bottle having a narrow neck consisting of a uniform graduated tube, and treated with 17·5 c.c. of pure sulphuric acid of specific gravity 1·831 to 1·834. The acid dissolves the casein and other non-fatty solids, generating heat, and liberates the fat in the form of an oily liquid. The bottle and contents are made to revolve in the machine round a central vertical axis at a high rate of speed—850 to 1000 revolutions per minute. The centrifugal force generated causes the fat to move towards the centre and to collect on the surface of the liquid. By the addition of hot water, and by further whirling, the whole of the fat is brought into the graduated neck of the bottle where its volume can be readily determined.

This method was devised by and named after Dr. S. M. Babcock, chemist at the Wisconsin Experiment Station in America. The machine on the English market is known as the Lister-Babcock Milk Tester, and may be obtained to rotate from four to sixteen or more bottles simultaneously.

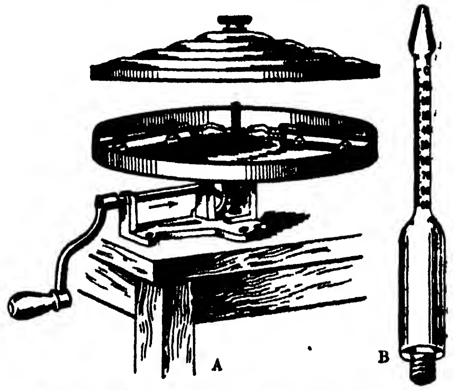
The process of testing milk by the Babcock method is a comparatively simple one. The

sample of milk should be at on near 60° F. It is thoroughly mixed by shaking and pouring two or three times from one vessel to another. The quantity is measured by means of a pipette holding 17·6 c.c. up to the mark on the neck and delivering 17·5 c.c., and introduced into the test bottle, which is held in a slightly inclined position to allow escape of air while the milk is flowing down the tube. 17·5 c.c. of the acid are measured by means of a special pipette, or an automatic measuring apparatus, and poured gently into the milk in the test bottle while the latter is being slowly rotated in the hand to wash down the milk in on the inner surface of the tube. The bottle is gently shaken till the coagulum formed has completely dissolved, placed in the machine, and revolved at the speed indicated for ten minutes. It is then filled up to the bottom of the neck with pure hot water at a temperature of about 200° F. Distilled water for this purpose is to be preferred. Hot water is introduced into the bottom of the machine to a depth of about ½ in., the cover replaced, and the bottle revolved for other two minutes. A further small quantity of hot water is introduced into the bottle, sufficient to bring the liquid well up into the graduated part of the tube, and the bottle whirled for another minute. A column of fat now shows clearly in the graduated neck, and can be measured with considerable accuracy. Before reading, the bottles are placed in water at 150° to 200° F. to bring the fat to from 120° to 140° F. Each of the graduated spaces occupied by the column of fat, measuring from the extreme limits, represents ·2 per cent, and five spaces 1 per cent, fat in the milk tested.

To obtain more accurate results, the speed should be increased above that recommended by makers to about 1000 revolutions per minute, and close attention paid to the cleaning of the bottles and accuracy of measurements. Test bottles are emptied while hot, rinsed out twice with cold water, and allowed to drain. Precautions should be taken to ensure a high degree of transparency in the fat columns. If the acid is too concentrated, or is mixed with the milk at too high a temperature, a dark-coloured flocculation accumulates at the bottom of the fat and obscures the reading. On the other hand, if too little or too dilute acid is employed, a white substance collects at the bottom of the fat. Hard or impure water added to the contents of the bottle causes a layer of foam to appear on top of the fat in the tube.

The percentage of fat in milk can be estimated by this method in a short time, with sufficient accuracy for all practical purposes. Special bottles are used in the testing of cream, skim milk, and whey. Cream is first diluted with an equal volume of water.

A more recent and more rapid method of testing milk for butter fat is by use of the Gerber centrifugal machine. This is the method most widely practised in this country and in Europe generally, though it does not seem to have supplanted the Babcock method to any extent in America. The principle of this test is the same, but the test bottles are smaller and are fitted with rubber stoppers (see fig.), while slightly weaker sulphuric acid is employed (specific gravity 1·820 to 1·825), the stronger acid being for winter use, and 1 c.c. of amyl alcohol (specific gravity ·815 to ·816) is added to facilitate separation of the fat and give a clearer reading. Into the clean test bottle are poured first 10 c.c. of the acid, then, gently down the side of the bottle, 11 c.c. of the milk sample, and finally 1 c.c. of the amyl alcohol. A well-fitting stopper is firmly inserted and the bottle shaken until the curd is completely dissolved, then placed in the machine and rotated at a moderate speed for five minutes. It is well to heat the body of the machine while running by means of a small bunsen or spirit lamp. The fat will be found to collect in the graduated neck of the bottle in an almost transparent column. Each smaller graduation represents ·1 per cent of fat, reading in this case from the bottom of the curve or meniscus on the top of the fat. If a bunsen or spirit lamp is not available, the bottles, before reading, should be immersed in hot water at 160° F. The advantages of this method over the Babcock are the clearer reading of the fat column, the shorter time in testing, and the smaller quantity of chemicals required.



A, Gerber Milk Tester, with test bottles in position.
B, Single test bottle on larger scale.

To obviate the use of sulphuric acid with the Gerber tester where such has to be carried from place to place, the inventor, Dr. Gerber, has introduced an alkaline substance to which he has given the name of 'Sal'. Sal is a pinkish-coloured powder, and is prepared for use by dissolving in a given quantity of water and decanting or filtering. Into the ordinary Gerber test bottle are introduced in turn 11 c.c. of milk, 10 c.c. of Sal solution, and ·6 of a c.c. of *butyl* alcohol. The whole is mixed and the bottle immersed in water at 140° F. for about three minutes, then rotated in the Gerber machine for five minutes. The reading will be found to correspond closely with that obtained by the acid method, but the time and trouble involved are alike greater.

In testing milk by any method it is obvious that, if accurate results are to be obtained, great care must be exercised in measuring out the small quantity of milk into the test bottles. One drop more or less will make an appreciable difference in the readings.

In the case of milk which has become soured and coagulated before testing, a few pellets of shot are added and the milk well mixed by shaking. To 100 c.c. of the milk 2 c.c. of strong ammonia are added, and the whole well mixed and allowed to stand for a short time, then tested in the usual manner. In this case the reading must be corrected by multiplying by 1·02.

Where the milk sample has become partially churned before testing it may be heated to 110° F. until the butter granules are completely melted, and shaken vigorously until a uniform mixture of milk and fat is obtained, then cooled in water to 60° F. and tested like ordinary milk.

In taking the specific gravity of milk for estimation of solids the Westphal balance should be used (see WESTPHAL BALANCE), and the milk brought to as nearly as possible 60° F. The instrument is first adjusted to balance exactly with the constant weight hanging in air, or wholly immersed in distilled water. The constant weight is next wholly immersed in the milk, and the small movable weights adjusted so as to bring the arm of the balance back to exactly the original position. The weights used and their respective positions on the arm of the balance indicate the specific gravity. This is a very simple and rapid method in practice, and gives a much more accurate result than the use of the lactometer.

Having obtained the fat percentage and the specific gravity, the approximate percentage of total solids of milk can be quickly calculated by means of one or other of the formulæ. Adopting Richmond's, viz.:

$$\frac{G}{4} + \frac{6}{5}F + \cdot 14 = T,$$

where G represents $\frac{\text{specific gravity} \times 1000}{1000}$,

F the fat percentage,

T the total solids;

if a sample of milk contains 3·7 per cent of fat and has a specific gravity of 1·032, then the total solids it contains

$$= \frac{32}{4} + \frac{6}{5}(3\cdot 7) + \cdot 14 \text{ per cent.}$$
$$= 8 + 4\cdot 44 + \cdot 14 \quad ,,$$
$$= 12\cdot 58 \text{ per cent.}$$

[W. ST.]

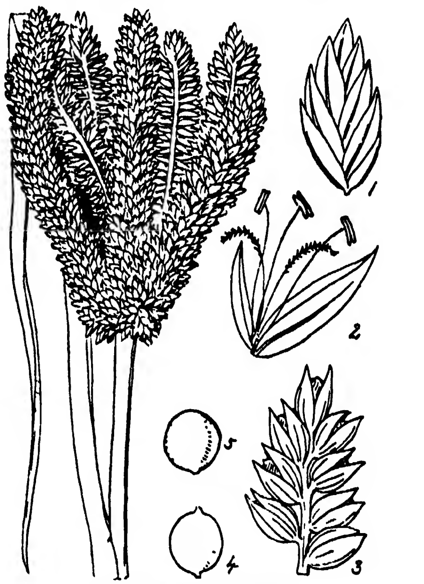
Milk Veins.—In dairy cattle about the time of calving we can observe two large veins running forward from the udder along the floor of the belly just underneath the skin and gradually becoming lost to sight. These are the subabdominal mammary veins, or popularly called the 'milk veins'; and it is a recognized fact that cows which possess prominent and well-developed milk veins are usually extra heavy milkers. This fact is quite in keeping with the physiological function of these vessels, whose duty it is to drain away the excess of blood from the overcharged vascular system of the active mammary gland. It must, however, be borne in mind that the sub-abdominal milk veins do not drain away the whole or even the greater part of the blood from the udder, because the true mammary veins, which run upwards into the abdomen from the upper back part of the organ, are the chief vessels, although they are not visible, being situated in the groin.

During the period of pregnancy the blood supply to the gland is gradually increasing, and reaches its height shortly after the birth of the calf. This is the time when the milk veins become most noticeable, as it is also the time when they are most required. [J. R. M'C.]

Milled Ewe, a ewe that has been crossed with a ram of another breed.

Millefolium. See art. YARROW.

Millets may be described as the subordinate cereals. That is to say, they follow rice, wheat, oats, and barley, though collectively they are more valuable than any one of these. In India, for example, the millets assume (with



Millet (*Eleusine coracana*)

1, Spikelet. 2, Flower. 3, Spikelet in fruit. 4, Seed with arillus. 5, Seed without arillus.

the pulses) the position of chief importance as human food. They are extensively grown in all parts of the country where the conditions are unfavourable to rice. In the wheat areas the millets are the food of the poor, as wheat is of the rich. In the rice areas, millet cultivation is often next to impossible, although it may be said that so varied are the millets that one or other may be grown under almost any conceivable climatic condition or on any soil, however poor or rich it may be. This extreme variability in species and adaptability individually is one of the chief features of merit of these edible grain crops. The following, in alphabetical sequence, are the chief millets:—

1. ELEUSINE CORACANA, Gaertn.—the *Marud* or *Rāgi*.—This is one of the most important millets of the mountainous tracts within the rice areas of India, such as South India, Mysore, Bombay, and Bengal. It is also largely grown in Japan. There are between six and seven million acres under the crop, of which Mysore

alone possesses a little under one-half. It is a rainy-season crop, but there are several distinct races, some early, others late. In South India, for example, it is sown from May to June, and again from October to December. But there is a great range in habit, some of the rainy-season forms (especially in Western India) mature in September, others not till November, but in Bengal as early as August. It is a four-months crop, and may be sown on all lands too shallow and poor for rice or too steep for terracing. On stony and sandy soils an early form may be grown that approaches the wild plant *E. indica*, and from that to the large and vigorous forms of rich agricultural lands, every intermediate condition exists. *Rāgi* is not a dainty food, but is very nutritious. It has one great advantage, namely, it may be left standing on the field till a convenient time for harvest, without being in any way injured, and further, the grain improves instead of deteriorating with storage. It may be preserved for many years without being attacked by insects or becoming mouldy. These are qualities of the greatest possible value, rendering the grain exceedingly valuable for storage against famine. Moreover, a paying crop can be obtained from almost any kind of soil, the yield being from 5 to 10 cwt. to the acre. The husked grain is reduced to flour and baked into cakes, or boiled and made into puddings. Lastly, a beer and spirit are prepared from the grain. Estimated at 400 lb. to the acre, the total yield in India would be 25,000,000 cwt. of edible grain.

2. PANICUM is one of the largest genera of grasses, and it affords several species that yield edible grains—the millets proper very possibly of the ancients. Of these special mention may be made of *P. crus-galli*, Linn., var. *frumentaceum*. This is the *Shāma* or *Sāme*, a rainy-season millet which is grown over the greater part of India, and ascends the hills to close on 7000 ft. above the sea. It is the quickest-growing of all millets, and may be harvested within six weeks of sowing. It is sown about May to June, and ripens from August to October. The yield is from 400 to 500 lb. grain, 1500 lb. straw. *P. maximum*, Jacq. (the Guinea Grass), a native of Africa, now extensively grown in most tropical countries. It is best propagated by root cuttings and on sandy soils. When established the plants should be ridged, in the direction of the slope, and watered and manured as freely as possible. The crop of fresh grass may be cut eight times a year, but the plantation should be renewed every third year. *P. miliaceum*, Linn. (the Common Millet, or *Chena*).—This species is supposed to have come originally from Egypt or Arabia, and is grown in India from the plains up to an altitude of 10,000 ft. above the sea, but nowhere to any very great extent. It is usually a hot-weather crop, being sown in February to March and harvested from April to May, the yield being about 700 lb. grain to the acre. The grain is considered nutritious, and in many cases is cooked whole like rice. In other cases it is boiled, then parched, or boiled in milk and eaten like a pudding. Lastly, *P. miliare*, Lamk., the Little Millet, the *Kungu* or *Kutki*, is smaller in all its parts than the last-mentioned, but nevertheless preferred in many instances, and extensively grown in the lower provinces of India. It is sown from March to May, and reaped from August to September.

3. PASPALUM SCROBICULATUM, Linn., the *Kodo*, an erect grass, native of India, where it is extensively cultivated during the rainy season. It is a favourite crop in the United Provinces for all poor soils, and on good land when mixed with cotton. It is also viewed as important on the alluvial soils of Kaira and Baroda, but never as a pure crop, and in conjunction with other plants. Though used as food the grain cannot be regarded as very wholesome, and in some seasons is even dangerous. Damp, cloudy weather towards harvest and a wet soil are said to produce a poisonous condition.

4. PENNISETUM TYPHOIDEUM, Rich., the Spiked Millet or Bajra (see SPIKED MILLET).

5. SETARIA ITALICA, Beauv. (the Italian or German Millet, the *Kangu* or *Kangni* of India), a millet extensively grown both on the plains and hills of India up to an altitude of 6000 ft. Though cultivated in India from ancient times, it is more likely to have been originally a native of China or of Japan, where it has also been grown from the most ancient historic times. It delights in an elevated dry soil, and two crops may be obtained from the same soil and harvested in September and January; but it is at once killed by stagnant water. It is a quick-growing crop, and is often resorted to following famine or scarcity. It is much esteemed as an article of human food, and is eaten in the form of cakes or of porridge, being specially valued as a flour in making pastry. It is highly prized as a food for cagebirds and for poultry, but as a fodder the straw does not hold a high place in popular favour.

6. SORGHUM VULGARE, Pers. (the Great Millet, Guinea Corn, *Juar*). See KAFFIR CORN and SORGHUM. [G. W.]

Milling.—The flour-milling industry has usually been an important one in all agricultural countries, but since ocean transport became so cheap the trade has been developed in other places where native-grown grain is not an important production. Cereal culture has stood still, or waned, in many old countries, while in newly developed lands it has increased. Cheap ocean transport has in a measure made the milling industry independent of the varying production of cereals. Generally speaking, the milling of wheat for flour has been carried on mainly in the districts where it was grown, but during the past few decades large mills have been built and considerable proportions of this grain milled at convenient importing points. This has led to the development of flour milling in many of the chief seaports of Europe, such as London, Liverpool, Marseilles, Hamburg, Venice, Hull, Glasgow, Leith, Antwerp, &c.; also in Buenos Ayres and Montevideo in South America. The same thing cannot be said regarding the milling of coarse grains for animal food, because the imports of these are more diffused, and they are not so much milled at concentrated points as in the case of wheat. A

large proportion of the coarse grains grown, such as barley and maize, are ground in small local mills, whereas large merchant flour mills are more a common feature in the larger industrial centres. Many of the old countries in Europe, though not producing all the grain they need, yet do the most of their own milling. The largest importer of flour is the United Kingdom, but she has only bought about one-eighth of her wheaten food requirements in that form during the past few years. Practically speaking, milling is done in the countries where the flour is consumed. Europe is the great wheat importer, while the exporting countries which provide the raw material are North and South America, Russia, the Balkan States, India, and Australia. Africa and the Orient are also buyers of wheat, but in only moderate quantities as yet. Although the consumption of wheaten flour is not in the same proportion in all countries, the extent of the milling industry in each follows that of population. If wheat flour is sparingly used it is made good by rye or maize, thus giving the millers of each country work to do in proportion to the population.

In almost all countries except those in the Far East, Central and North Africa, and many parts of Russia, the milling of wheat into flour is now mainly done by means of steel and porcelain rollers, with silk-sifting machinery, and this method is commonly called the 'roller process'. There still exist, however, in old countries large numbers of ancient millstone mills, but nowadays only a portion of these make flour, the majority being either derelict or devoted to the grinding of coarse grains for cattle food—in other words, provender mills. In Western Europe, America, Canada, Argentina, South Africa, Australasia, and India, the manufacture of wheaten flour in a pure form is carried out mainly by means of the roller process. In the larger establishments the plan of grinding and purifying the broken wheat and sifting out the flour is more scientific and elaborate than in the case of the smaller mills. In Central Europe the roller process in the large mills is very much more complicated than in the mills of America, the United Kingdom, and the other countries. In other words, Hungarian mills have the distinction of being the most elaborate in detail; and it is notable that the Hungarians were also the first to use rollers for grinding wheat. Generally speaking, the complete roller process was not made a practical one until about the 'seventies in the last century. Its fame then began to spread, and so rapid was the revolution from the old system to the new—from the methods of the millstone to those of roller milling—that by 1890 almost all the merchant flour mills in the world were converted to the new system.

Briefly, the process of making flour by means of rollers is somewhat as follows: The grain is first thoroughly cleaned and blended in suitable proportions to suit the requirements of each mill's customers. In the countries where the wheat grown or imported is more or less of a definite character, blending is not so necessary; but in those places where the supply comes from a variety of sources, blending is an important part of the science of milling. For instance, Spring American, Russian, and Hungarian wheat flours possess a high quality of gluten, which enables the baker to make from them more bread per sack of flour than can be obtained from such flours as are manufactured from American Winter, English, Australian, and Chilian wheats. Middle-grade wheats, as regards bread-yielding qualities, are those grown in Kansas, Argentina, and India. The wheats of Western Europe are mostly weak and mild, while those of hot countries such as India, Chili, Australia, North Africa, Spain, and California are of a ricey nature. It is curious to note that the strongest wheats—those which contain gluten of good quality—are mostly grown in countries which have long winters, where the snowfall is heavy and the frosts severe. A sack of flour of 280 lb. made from the best glutinous wheats will yield from 100 to 110 four-pound loaves of bread, while one from the soft mild sorts, such as English, French, German, Dutch, New Zealand, Oregon, and Eastern Canadian, &c., will produce less than 100, say from 90 to 96.

After cleaning and blending, the wheat is broken up by a pair of steel-fluted rollers, the floury portion of the kernel being sifted out. The broken wheat then passes to a second pair of fluted rolls, the stock being again sifted. This process is repeated until the bran is clean and free from flour. Usually it takes four or five breakings, but it may be done with three, while in some of the elaborate Hungarian mills as many as seven breakings are made. The outsiftings from each breaking are sorted by wire sieves and air currents into flour, dunst, middlings, and semolina, the second named being the smallest granular stock and the semolina the largest. The three latter are unfinished products, which have to be first purified by air currents and silk sieves, and then reduced to soft meal by smooth steel rollers (sometimes by porcelain rollers), and then dressed through silk cloth stretched upon reels or sifting frames. After each grinding and dressing there is a granular residue, but ultimately after seven or eight grindings, which are called *reductions*, all the flour is extracted from the offal. The flour made in the breaking process is much inferior to that made in the grindings of the purified granular atoms of the wheat grain. A class of semi-pure stock is sorted out from the break meals, and this produces a middle grade of flour. The average yield of flour of all qualities from the wheat is about 70 per cent; there is about 15 per cent of bran, 5 per cent of coarse, and 10 per cent of fine offal. In Hungary and in other parts of the Continent where a dark flour can be sold, or mixed with rye flour, yields as high as 75 to 78 per cent are obtained. The proportion of the flour made by the breaking rolls is from 10 to 20 per cent of the wheat, according to its character and the process of sifting employed. In Hungary as many as eight qualities of flour are made from one kind of wheat at the same time. In America a common practice is to make three kinds, viz. 'Patents',

'Clears', and 'Low Grade'. Sometimes all the flour from the numerous dressing machines in a roller flour mill are blended together, and this is styled a 'Straight Grade'. This is a feature in milling in Australia, but in the United Kingdom two kinds are generally made from one mixture, although sometimes three and four are turned out.

The cost of a complete flour mill of average size and built on modern lines is about £2000 per sack of hourly capacity. Large mills may be put up for less, but small ones, if on a good and full system, may cost more. The figure named includes site and power, as well as the mill machinery. The average power needed for operating a roller flour mill is about 12 h.p. per sack of 280 lb. of hourly capacity. Very small and simple process mills can be operated with as low as 8 h.p., but the largest merchant mills require at least 16 h.p. per sack. The majority of European, Australian, Indian, South American, and African mills are driven by steam power, but a considerable number of mills in the countries which have a large rainfall are driven by water motors, with steam as an auxiliary; those totally driven by water-wheels being of the smallest class, except in a few cases where the water power is never below the minimum requirements. Internal-combustion engines are largely used in America and Europe for small mills, the fuel being either coal or petrol gas. Wind power is seldom used in connection with roller flour mills, and then only for very small plants in country places.

The staff required to operate a steam mill making ten sacks of fine flour per hour during the day shift includes the following: head miller, rollerman, purifierman, silk-machine tender, sweeper and oiler, engine driver, sack mender, screensman, silo-man, warehouseman, millwright, handy man, flour packer, offal weigher, and a youth or two for helping where needed. The cost of manufacture varies according to the conditions of a mill. As a rule, the cost of make in the large mills is much less than in small ones, and the mills in each country differ much in the matter of working expenses. An average mill in the United Kingdom has a manufacturing cost, including fixed charges on capital account, depreciation, and all expenses in connection with its working, of about 2*s.* 3*d.* per sack, which, together with selling, local delivery, and office expenses, will raise the figure to a little over 3*s.* per sack. The large average merchant millers of Europe and America may be able to work their business somewhere between 2*s.* and 2*s.* 6*d.* per sack of 280 lb., but these estimates do not include the packages or bags. In exceptional cases where the trade is on wholesale lines, the cost may be even less than the smallest sum stated. In the case of the smallest class of mills the cost will often be as high as 4*s.* per sack, though instances of a low manufacturing cost can be found among even small millers.

The number of complete roller flour-mill plants in the United Kingdom is probably not far short of 1000, though the firms and persons who operate the mills do not number more than 800. Only about ten United Kingdom firms produce over 100 sacks of flour per hour each, while the number making over 20 sacks per hour is less than 100, without reckoning five 'leviathans', whose average output is about 250 sacks per hour each. Liverpool has the largest milling capacity of any British port, but London's latest additions to its milling power make it take almost equal rank with Liverpool, the two places having a total output of fine white flour of about 1200 sacks per hour. The average capacity of all British mills is about 7 or 8 sacks per hour.

In 1879 we find that the number of mills making flour in the British Isles was reckoned at about 10,000, and was mainly composed of small country water and wind-driven mills, each having from two to four pairs of millstones. The change to the roller process practically wiped these out of existence as regards flour making, but several thousands of them still exist, being used for grinding maize and barley, &c., a large portion of what they grind being imported, the barley chiefly coming from Russia and the Balkan States, while the maize comes mainly from the United States, Argentina, the Black Sea, the West Coast of Africa, &c.

The process of milling maize and barley, &c., is very simple, and is usually done by means of millstones, emery disk mills, and attrition grinders. More care is being taken in provender milling, and improved grinding mills with sifting machinery are rapidly coming into favour. The crushing of oats for horse food is a large trade, which is done by the provender millers, although the flour millers do a great deal of this class of work.

Another section of cereal milling is that of oatmeal making. This is largely confined to Scotland, but Irish millers also have a great many plants engaged on the work. The process of making oatmeal consists of highly drying the grain and then shelling it by millstones. The hulls are removed by air currents, and the clean groats are cut by millstones or cutters into the desired size of meal—coarse, medium, and fine, the finest meal being the siftings after the various breakings, &c. The Scotch meal has a great reputation, and is considered to have high nutritive quality.

Maize is also milled in considerable quantities for use as brewing material. The germs of the grain are first extracted, and then the starchy remainder rolled into flakes for blending with the malt. It is also milled for the production of saccharine matter. Large works for the production of these products are to be found in London, Belfast, and Hull.

In seed-crushing the primary object is the production of vegetable oils, and not feeding-stuffs as in the case of cereals. Practically all the milling of oleaginous seeds in the United Kingdom is confined to those seeds which are imported. Large quantities of linseed come from Argentina, Russia, and India, while cotton-seed is largely imported from the Gulf ports of the United States, Egypt, and India. Large quantities of oil-bearing and other seeds are brought to this country from India and Africa,

as well as rapeseed from Russia. Soya beans were first imported to Europe from Manchuria, in cargoes, about 1907, and are very valuable as oil-bearing seeds. Hull, London, and Liverpool are the chief centres for milling oilseeds, and two methods of extraction are in use. That most favoured is by a grinding, steam-heating, and pressing process; but there is another mode of extraction, viz. by means of a chemical solvent. A seed-crushing and cake-making plant for a pressing process would need four men to operate it, while turning out cake and oil from one ton of seed per hour. The mill would require about 50 h.p., and the machinery, engine, and boiler would weigh about 80 tons. Seed-crushing is a large industry in New Orleans and Galveston, as well as in several of the Russian ports. [G. J. S. B.]

Mills.—The machinery and methods of modern wheaten flour manufacture are of an elaborate and complicated nature as compared with those in vogue up to the last quarter of the 19th century. The reason for this elaboration may be attributed entirely to the desire amongst the millers to excel in their art, and the demand for higher quality of food which has kept pace with the advance of civilization and refinement.

To understand the development or evolution in the process of flour manufacture it is necessary to explain here that the simple pounding of the wheat and its cooking, without any subsequent separation whatever, was the first stage. A crude separation of the husk of the grain was probably the first improvement adopted. Then came various changes in grinding surfaces, until by common consent the grinding medium almost universally adopted for wheat was the French burr millstone revolving on a vertical spindle called the 'runner', with its prepared surface pressing down against its fellow stone—the 'bed stone'—which was stationary. The grain entered at the centre of the running stone, and in its passage to the periphery was ground between the surfaces of the two stones more or less at the will of the operative, who had a mechanical contrivance for raising or lowering the running stone. These millstones reduced the wheat at one operation into flour and offal (bran and sharps), which were separated from each other by a simple cylindrical sifter covered with woven wire or bolting-cloth of such a fineness as the district demanded. It was found, however, that to reduce the wheat in stages, so as first to eliminate the husk before reducing the kernel, improved the quality of the resultant flour, and this discovery through many gradations has now been carried to great perfection.

Naturally, with improved methods of production came improved methods of preparation of the grain before grinding. As the United Kingdom receives her wheat supplies from a great variety of sources, she has to deal with many qualities, all of which have first to be cleansed from impurities and made entirely homogeneous before milling.

This is done by passing it over sieves of metal perforated so as to remove all possible seeds and extraneous matter, thence to air currents to remove grains of light specific gravity, thence to cylinders semi-perforated with symmetrical indentations to extract cockle, oats, barley, and seeds of different physical structure, and thence to a scourer or scrubber to remove by attrition adhering dirts. This might suffice for mellow wheats, but all hard wheats are now subjected to a washing process which thoroughly cleanses the grain and also at the same time softens it, ready for the mill proper.

Then follows the mill itself, which is usually in five sections—'breaking', 'scalping', 'purifying', 'rolling' or 'reducing', and 'dressing'.

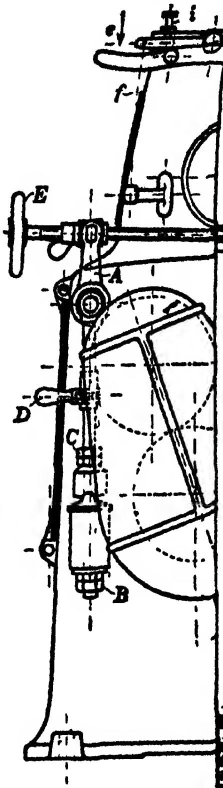
1. *Breaking* is done on machines composed of pairs of chilled iron rollers in groups of four or five according to the size of the mill; the first pair being fluted or grooved 10 or 12 cuts to the inch spirally to the axis of rotation, and each subsequent pair finer, until the fourth or fifth is grooved 24 to 28 per inch—one roller being driven two and a half times faster than the other by means of gear wheels so as to 'break' or sever the wheat at each operation, until all the kernel is released from the husk, which is then sacked off as bran.

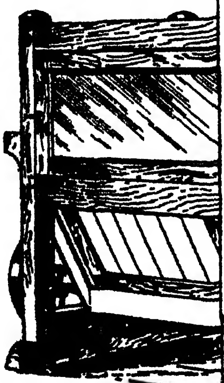
The machine commonly used for this purpose is shown in Plate, fig. 1, and consists of a four-roller mill, being two pairs of chilled iron rollers operating in the same frame, the upper roll in each pair being placed a little off the vertical in relation to the lower one, mainly with the object of getting a more even distribution of the stock to be ground, across the whole surface of the rollers. The top roller is the 'fixed' one, being so named because the bearings which carry it are not adjustable. This is also the faster-running roll of the two, the normal speed for this roller, of from 9 to 10 in. diameter, being 250 to 300 revolutions.

The lower roller is carried on an adjustable lever, which permits of more or less pressure being applied to the stock to be ground; and at the adjustable end of this lever is a coil spring, which permits of the passage of any hard substance through the rollers without damage.

2. *Scalping* is the process of separating the kernel of the grain from the husk after each 'breaking', and this may be done in many ways. The simplest is by means of a reciprocating sieve (see Plate, fig. 2) suitably covered with wire screen; but with the object of reducing the quantity of attrition flour made in this operation, recent developments have gone in the application of air currents to suck out the flour made, and at the same time grade the larger granular particles made. This is styled pneumatic 'scalping'.

3. *Purifying* is the term applied to the process of removing the light branny particles from good semolina and middlings by means of a reciprocating sieve placed in a wooden frame with a fan superposed, so that the air it draws when revolving must pass through the sieve along which the stock to be purified is traversing and suck out all light impurities, while the pure stock, being of heavier specific gravity, drops through the sieve. This sieve being divided into sections each of which has a valve to regulate the strength of the air current, has also corresponding mesh of silk sorting cloth.





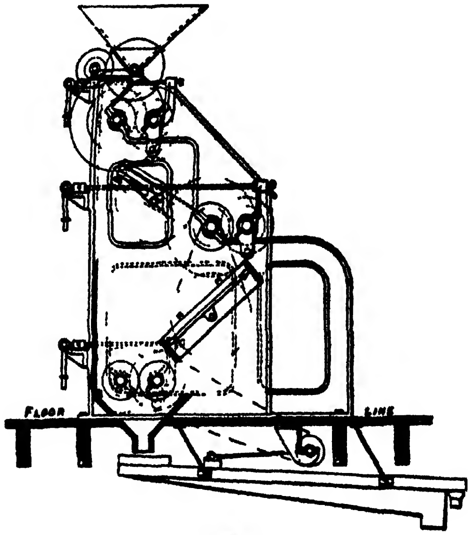


Fig. 5

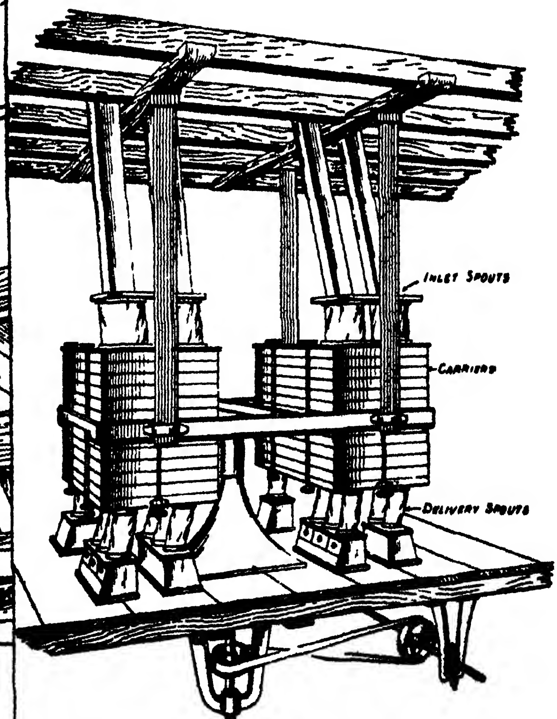


Fig. 8

ranging from fine at the head end to coarser mesh at the tail end. The overtails are also submitted to further aspiration. See Plate, fig. 3.

4. *Rolling* on smooth rollers by graduated stages is next applied to the semolina or purified sections of the kernel of the grain; and this is done on a machine similar in many respects to the one illustrated in fig. 1, except that these rollers are smooth instead of fluted, their differential speed is as 4 to 5 instead of 2½ to 1, and scrapers are applied to keep them clean. This grinding is carried out in steps until all the flour is extracted.

5. The *dressing* is that process of submitting the material ground on the smooth rolls in the preceding stage to a silk-covered cylinder or sieve to remove the flour already made, and reject all unfinished flour to be again ground. This machine consists of a set of beaters rapidly revolving in a cylindrical frame covered with silk stretched tightly around it and revolving slowly in the same direction as the beaters, a spiral twist being given to the beaters to carry along from head to tail such particles as are not beaten through the mesh of the silk. See illustration in Plate, fig. 4.

Latest improvements in flour manufacture have all been in the direction of lessening the abrasive action in the 'breaking' and 'scalping' sections of the mill. These have either taken the form of uniting the 'breaking' roller and the sieve scalper, or in placing the first break rollers on the top floor of the mill and its 'scalper' immediately below it but above the second 'break' rollers, which are in turn followed by 'scalper' No. 2, and so on from top to bottom of the mill, as in Plate, fig. 5. Another successful method introduced quite recently has been the application of air currents controlled by valves in the hopper of the roller mill itself, as in Plate, fig. 6, and a further one in the pneumatic elimination of the flour made on the 'break' rollers, with further separations of semolina and middlings by the same agency.

All these most recent developments have for their object the lessening of the abrasion of the bran during the process of removing it from the kernel or flour-producing portion of the berry.

The lessening of the diameter of the rollers from 9 in. to 6 in., or even 5 in., so as to reduce the duration of contact between the grain and the roller itself, as also the form of the flute or groove cut into the surface of the roller, are important details which are receiving the attention of the experts engaged in the milling industry. The most recent experiments go to prove that provided sufficient rigidity is given to the roller, the smaller the diameter of the roller the more pure is the 'break' flour, the cleaner is the semolina, and better the bran produced.

In the flour-dressing section (§ 5) are also contending schools, which strive for the supremacy of a plane sieve sifter (see Plate, figs. 7 and 8) for separating the flour from the offal after the smooth roller reductions, instead of the centrifugal dresser as in fig. 4; and if only certain mechanical defects are removed, so as to prevent undue vibration of the machine and the clogging up of the meshes of the silk covers, there is undoubtedly a dominating factor in this type of dresser in this country, such as has been obtained in every other country practising first-class milling methods.

The machinery used for generations past for the grinding of seeds or grain for cattle has been the millstone, composed either of French burr, Derbyshire Peak, or other material, and has consisted of a bed-stone or runner, the usual type being that the runner was on the top; but the diagram in accompanying Plate (fig. 9) is a modern application of the millstone type, which shows the under stone being the runner. The balance of this is preserved by an adjustable weight, so that the surfaces are kept perfectly in alignment. This method of construction permits of a high speed, and results in rapid grinding and a cool meal. This type of millstone is used for grinding maize, barley, beans, oats, or any other cereal for cattle feeding.

Another type of machine which has recently gained favour is the roller mill, consisting of three or more pairs of rollers placed one over the other, with sieves in between. This type of machine consists of fluted rollers of chilled iron running at a differential speed, with the usual lever adjustment with recoiled springs. The advantages of this machine over millstones is that it takes less power, requires no stone dresser, and produces cool meal at a minimum cost.

Another modern type of mill is shown in Plate, fig. 10. This machine consists of a standing disk, which is adjustable, and a running disk, the surfaces of which are composed of emery or other hard composition, which is a very durable and rapid grinder. For reducing husk of bran, oats, or barley to fine powder, this type of mill is unsurpassed.

The grinding of cottonseed is usually performed on a disintegrator, of which fig. 11 (in Plate) gives an outline diagram. The letterpress connected therewith explains its action. The screens H H may be changed to suit the fineness of the meal required. This machine runs at a high speed, and is made at various capacities.

For grinding linseed, a pair of rollers is generally used running at a differential speed, as in the illustration in Plate (fig. 12).

Mustard Making. — The process of manufacturing mustard has been recently considerably improved. Whereas the oldtime method was to use stampers or pounders which beat the seed in mortars, which seed had afterwards to be put into sieves by hand and sieved, and again return to the stampers, this has been superseded by a roller process specially adapted for the work, on the gradual reduction lines. The seed is first dried on a kiln, is then spl[illegible] with a special machine, and the husk aspir[illegible]ed away. The kernel of the seed is then reduced on smooth rollers, and dressed on centrifugals similar to those used in flour manufacture, with special additions to keep the silk mesh open, as the oily nature of the seed would otherwise choke the dressing medium. By these means, the process which was originally so laborious and

tedious is now made automatic and continuous, so that a high grade of mustard flour can be produced at a minimum of waste in the shape of dross. The machinery adopted in this process is very similar to that used in flour manufacture from wheat, but with certain modifications to suit the nature of the seed. [A. R. T.]

Mimosa, a large genus of Leguminosæ comprising trees, climbing shrubs, and herbs, prickly and unarmed, natives of the Tropics. The species which are sensitive to the touch are those most cultivated in gardens. These are *M. pudica*, 'Humble Plant', a perennial with red flowers, usually treated as an annual; and *M. sensitiva*, Sensitive Plant, an evergreen shrub with purple flowers, which is, however, not quite so sensitive as *M. pudica*. Both are natives of tropical America. The seeds are sown on a hot-bed in spring, and warm greenhouse treatment is required. Several species of Acacia are also familiarly known as Mimosa. These are extensively cultivated on the Riviera for their yellow flowers, which reach this country in large quantities in February and March. [W. W.]

Mimulus (Monkey Flower), a genus of Scrophularineæ containing about forty species distributed over all the continents except Europe. Those cultivated in gardens are showy border flowers, best suited by a moist situation, and are well adapted for naturalizing by the side of streams, &c. One species has become naturalized in this country, even in many parts of Scotland. *M. cardinalis*, red flowers; *M. luteus* and its varieties; *M. moschatus*, the familiar yellow-flowered Common Musk, and its superior variety *Harrisoni*, which are great favourites as pot plants for dwelling rooms and window sills; and the hybrids derived from *M. luteus* and *M. cupreus*, and known as *M. maculosus*, are among the best kinds. The tiny seeds are sown under cover in March. They should be scattered on the surface of the soil, and covered very lightly, if at all. Propagation may also be effected by cuttings. With the exception of *M. glutinosus* the shrubby species are but little grown. [W. W.]

Mineral Manures. See art. ARTIFICIAL MANURES.

Mineral Phosphates.—The best-known mineral phosphates, or phosphorites as they are more frequently called, arise from the accumulation in fissures or cavities in limestone of material leached out by percolating waters from the limestone itself or from some more distant source. Insoluble residues from limestone, such as gravel, sand, and iron-stained clay, commonly occur associated with these deposits. In the region of Quercy, on the borders of the French departments of Lot, Tarn-et-Garonne, and Lot-et-Garonne, phosphates have thus been laid down from solution in concretionary forms on the insoluble materials or on the walls of fissures in the Jurassic limestone of the district. These deposits are associated with the bones of early Cainozoic mammals. They have been quarried at a number of places, the calcium phosphate in the layers now worked amounting to about 45 per cent (P_2O_5 about 21 per cent). There is much difference of opinion as to whether these phosphates have arisen from the decomposition of bones in the gravels on the surface of the limestone, or have been imported, like those in a basalt in Aveyron, in solution from a subterranean source. The same doubt exists as to the origin of the nodular phosphorite (*Lahn-phosphorite*) worked in Nassau, containing 30 per cent of phosphoric anhydride (P_2O_5). This material lies partly in pockets eroded in Devonian limestone, and partly in detrital beds above.

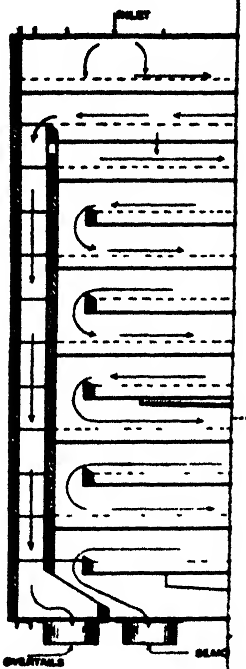
The upper part of the Chalk in the south of Belgium contains in places, as at Mons, abundant brown nodules of calcium phosphate; and these have accumulated, with phosphatized shells and teeth and bones of fishes, in a conglomerate above, worn from the Cretaceous deposits. *Phosphatic Chalk* occurs also in the north of France, and at Taplow in Buckinghamshire (Cornet, Quart. Journ. Geol. Soc. 1886, p. 325, and Strahan, *ibid.*, 1891, p. 356).

The accumulation of calcium phosphate around fossils, or within their hollows in the form of phosphatic casts, has given rise to many phosphatic deposits, notably in Cretaceous strata. The bed called the Cambridge Greensand in the Lower Chalk near Ely contains a layer known to its workers as the 'mineral-bed', some 10 in. thick, one-tenth of which consists of phosphate, while nine-tenths are marl and sand (Geol. Survey Memoir to sheet 51 s.w., 1881, pp. 26 and 126). The nodules and casts of ammonites and other molluscs are derived from the natural denudation of the Gault Clay, the material being thus concentrated in a later stratum, as in the case of part of the Mons phosphorite. Brown ferruginous phosphatic casts and nodules have also been worked in the Lower Greensand at Potton and Upware in Bedfordshire. The fossils in this bed are in large part derived from the underlying Wealden and Jurassic strata, but appear to have become phosphatized in the Cretaceous sea, after being washed out from their original positions. Somewhat similar deposits of phosphatized nodules and fossils are worked in the Cretaceous beds of northern France. Analyses are given by Dehérain, Chimie agricole, 2me éd., 1902, p. 832.

A deposit of much later date, including numerous sharks' teeth, and ear-bones of fishes and whales, with brown lustrous nodules which are often styled coprolites (see art. COPROLITES), occurs near Felixstowe in Suffolk in the Red Crag stage of the Pliocene system. It has yielded some 55 per cent of calcium phosphate (25 per cent of P_2O_5). Much of this material has been derived from the Eocene London Clay.

Massive and often nodular phosphorite occurs over a very large area in Russia, between Moscow and the Black and Caspian Seas. The bed lies at the base of the Chalk, but is not particularly rich, the phosphoric anhydride averaging only 20 per cent. A far richer accumulation of remarkable crystalline concretions, resembling cannon-balls, occurs in the Silurian beds of Podolia, in the south-west of Russia.

The phosphorite occurring in Eocene beds between Charleston and Broad River in South Carolina was believed by Prof. Shaler to have accumulated in swamps. The layer contains



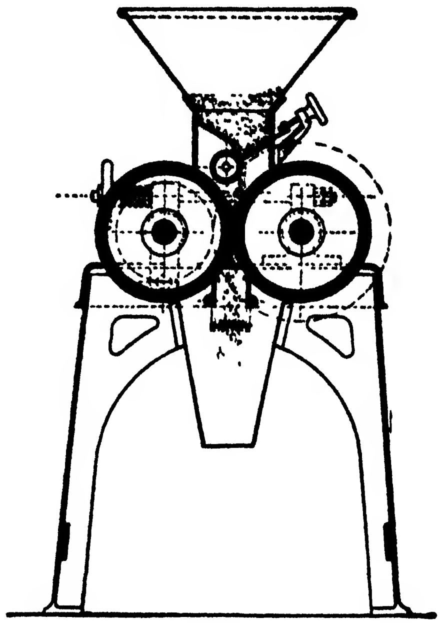
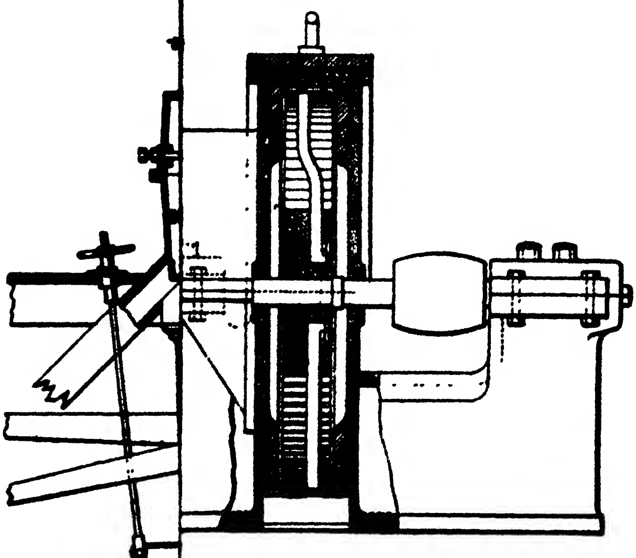


Fig. 12



nodules with 25 to 70 per cent of calcium phosphate, and numerous mammalian bones and teeth of sharks.

Phosphorite occurs in the Carboniferous strata of Burdiehouse and other places near the Firth of Forth. The bedded black phosphorites in the Ordovician (Bala Limestone) strata of North Wales are regarded as due to the localization of calcium phosphate derived from decaying brachiopods and other organisms. Any calcium carbonate originally present has been dissolved out by percolating waters.

Massive phosphorites occur in Estremadura in Spain in veins and pockets of slates of early Palæozoic age; the phosphate has probably been imported by waters from some distant source. The deposit yields about 33 per cent of P_2O_5. Enough has been said to show that phosphorite may be expected in many regions where it has not hitherto been detected, whether in veins or in beds of nodules and phosphatized fossils. At the present day, concretionary calcium phosphate is forming among the calcareous and glauconitic oozes in the oceans, the phosphate even chemically replacing the shells of foraminifera, as well as binding them together. Some of the nodular masses contain 20 per cent of P_2O_5 ('Challenger' Reports, Murray and Renard, Deep Sea Deposits, 1891, p 391).

The commercial value of phosphorite deposits was for the most part recognized as recently as 1850 (see Dehérain, Chimie agric., 1902, p. 826), and good examples may contain 50 to 75 per cent of tricalcic phosphate, which corresponds to about 23 to 34 per cent of phosphoric anhydride (P_2O_5), also called phosphoric acid.

Details as to phosphorites in many lands are well given in R. Penrose, 'Nature and Origin of Deposits of Phosphate of Lime', U.S. Geol. Surv., Bull. 46 (1888), and Fuchs and Delaunay, Traité des gîtes minéraux, tome i (1893), pp. 342–410. Good maps of the French deposits occur in Risler, Géol. agricole (1896). See also arts. APATITE, COPROLITES, GUANO. [G. A. J. C.]

Mineral phosphates are most largely used in the manufacture of superphosphate (see SUPERPHOSPHATE), but some phosphates, like the Florida Pebble and the Charleston phosphate, may be ground up into a fine powder, and in this form used as a manure. Ground mineral phosphate is of somewhat low value, but it may be employed as a manure for turnips and all root crops, provided the fineness of the grinding be such that the natural soil agencies can dissolve the constituent particles. It is, however, much less effective than basic slag and superphosphate, and its use is therefore not to be recommended. Ground mineral phosphate is unsuitable for soils rich in lime, and gives its best return on soils rich in organic matter, such as peats and mosses. It gives good results on soils containing plenty of moisture; and is more available when used in conjunction with sulphate of ammonia. Ground mineral phosphates are extensively used in the United States of America, where, in virtue of their fineness of grinding and their cheapness, they give—for equal money values—results comparable to those of superphosphate. [R. H. L.]

Minorca Fowl.—No breed has contributed more to the development of egg production in this and other countries than the so-called Minorca, which was perfected in the south-western counties of England, where it was bred for a long series of years before it became known elsewhere. It would appear that it was introduced from the Spanish Peninsula about seventy or eighty years ago, and its excellent qualities, more especially in regard to the large size of the eggs as well as in the number produced, gave it great popularity in Devon, Cornwall, and the adjacent districts. How it received the name Minorca is difficult to say, but it may be explained that this breed is evidently descended from what is known as the Castilian fowl, which is largely black in plumage, and which is very generally distributed throughout Spain. It may be mentioned also that certain qualities appear to fit the conditions found in south-western England. About thirty years ago it became known elsewhere and attained a very great measure of popularity; in fact it is met with in many parts of the country at the present time. Of the Min-

Black Minorca Fowls

orcas there are two varieties, namely the Blacks, which are most popular, and the Whites, which are sports therefrom. Our remarks, however, will deal specially with the former, as they are of the greatest use. These birds have what is known as Mediterranean characters, namely, a fairly light body, a medium length of neck, a large single comb (which stands upright in the cock and falls over in the hen), long pendent wattles, and white earlobes. They are clean-legged. The Black Minorca is of a dense black in colour, and the cock has a large flowing tail. In size these birds run 6 to 7 lb. in the males, and 5 to 6 lb. in the females. In respect to qualities, they are moderate in the quantity and texture of the flesh, but in this direction are better than almost any other of the non-sitting varieties save the Houdan. The flesh and skin are grey, which is in conformity with the dark legs. They are not kept for their table properties, but as egg producers, and in this respect they have very few rivals. The hens are most prolific layers, and the eggs are large in size, frequently reaching upwards of 2½ oz. The shells are pure-white, and there can be no question that this is a point which appeals greatly to poultry-keepers of all kinds. It must be recognized, however, that, as is usual with large-sized eggs, the white is less in density than where the eggs are smaller. The point which has to be kept in view with regard to the Minorca is that, as indicated by the fact of their feathering somewhat slowly, they require favourable conditions, and it is found that they do not thrive well in very cold, exposed districts, as they are not nearly so active as some other of the Mediterranean races. Hence they have found their greatest popularity in the western and southern counties of Britain. It would appear that this is largely a question of activity of habit; some other breeds, such as the Leghorn, seem to be stimulated by cold winds, but that is not so with the Minorca, and therefore one of the first points to consider is whether sufficient shelter can be given to these birds during unfavourable seasons. It may be explained also that whilst at one time the Minorca was very largely kept in some of the eastern counties as a farmer's fowl, that is no longer the case, and we believe that it is entirely due to the fact that it has not proved to be so hardy as others which might be named. [E. B.]

Mint is the common name for a genus of hardy perennial dicotyledonous herbs belonging to the nat. ord. Labiatæ. The Mint genus, indigenous to the temperate regions of both hemispheres, is characterized by the well-known odour due to the presence of oil of peppermint, used for communicating flavour to peppermint lozenges, to peppermint water, to mint sauce, &c.

All the species have creeping underground stems, from which the plant is very easily propagated by division. Although mints are endowed in a high degree with powers of variation and of hybridization, the varieties and hybrids show great constancy, for they are shy seeders, and it is their nature to propagate from the underground stems much more extensively than from seed. The cultivated Peppermint, for example, is a hybrid of Spearmint (*Mentha viridis*) and Water Mint (*Mentha aquatica*) which has remained constant from ancient times; this constancy is due to the circumstance that the hybrid is completely sterile, and propagated only by division.

Three species are cultivated: (1) Peppermint (*Mentha piperita*), for oil of peppermint. (2) Spearmint (*Mentha viridis*), for sauce making. (3) Pennyroyal (*Mentha Pulegium*), for medicinal purposes.

PEPPERMINT is cultivated as a field crop on rich loams in the south of England at Mitcham and Tooting, also in Michigan, France, Germany,

Peppermint (*Mentha piperita*)

1, Flower. 2, Corolla laid open.

and Italy. The peppermint oil is produced in special glands, which are most abundant on the leaf. The oil from the stems is inferior in quality, and less in quantity. The yield of oil from a peppermint crop is, on the average, about ¼ per cent, *i.e.* about 6 or 7 oz. per hundredweight of crop. The crop is taken when in full flower, in July or August, and yields most oil when the weather is bright and sunny: rain is very detrimental. The plants, as soon as cut, are boiled in water (distillation), and the vapour, condensed in a 'worm', is collected in a 'separator'. The oil floating on the fluid in the 'separator' is transferred by means of a spoon to a filter, and the filtered oil when bottled is ready for sale.

The Peppermint shows the following distinctive characters: the leaves are stalked (petiolate); the upper surface of the leaf-blade dark-green and quite bald; the flowers are in whorls, and aggregated into long cylindrical terminal spikes.

Spearmint is cultivated in gardens for culinary use. It is distinguished from Peppermint by the leaves having no petiole (sessile). A common variety (var. *crispa*) has crisped foliage.

Pennyroyal for medicinal use is cultivated on moist loams. It is distinguished by the excessively small leaves, seldom above ½ in. long, by the margin of the leaf-blade destitute of teeth (entire), and by the arrangement of the flowers, not aggregated into cylindrical spikes, but kept apart in separate whorls, one whorl per pair of leaves.

Species of Mint often occur as weeds in wet pastures, *e.g.* Marsh Whorled Mint (*Mentha sativa*), and in corn, *e.g.* Corn Mint (*Mentha arvensis*). On flooded marshes the Water Mint (*Mentha aquatica*, L.) occurs as a weed, and communicates a specific odour to the hay. See also Herb Industry. [A. N. M'A.]

Miocene System, a system of strata formed after the Oligocene and before the Pliocene system. No beds of this age are known in the British Isles, though the clays of Bovey Tracey and the basalts of our north-west volcanic area were formerly regarded as Miocene. Typical Miocene strata occur in northern Italy, where they are continuously of marine origin. Many European areas had, however, already risen above the sea, and the Lower Miocene deposits of France and Switzerland were mostly formed in lakes. Then came a return of marine conditions, followed by a reassertion of the growing continental land. The famous '*faluns* of Touraine', on the south of the Paris Basin, are marine sands of Miocene age, which contain large quantities of fossil shells; they have hence been used, in the country south and west of Orleans, to ameliorate the clay lands of the district. Even isolated patches of these *faluns* have been highly valued by agriculturists, as near Tours and Blois, the beds yielding from 40 to 75 per cent of carbonate of lime. The great plain of Orleans, stretching towards Bourges and Blois, presents, but for the *faluns*, poor land formed of Miocene clays, and has only been brought to prosperity by carefully selecting areas capable of improvement, and by converting others into forest land or pasture. The Miocene of the south of France, as in the plain from Toulouse to Pamiers, is more generally calcareous and fertile; and in the south-east it contains pale-coloured limestones that can be quarried. These beds, indeed, pass north-eastward beyond Chambéry into those of Switzerland, where the soft marls and calcareous sandstones produce rounded foothills to the Alpine chain, and are styled by the general name of *mollasse*. At Œningen, near the west shore of the Lake of Constance, these beds have yielded admirable remains of fossil plants. The rich lowlands of north-west Switzerland are largely formed of 'mollasse' of Oligocene or Miocene age; the hills of this region are mostly forest-covered, and quarries in them show the characteristic pale-yellow colour of the rocks.

The Miocene deposits of the flat land round the Rhine at Mainz are estuarine or freshwater clays and sands, with some limestones. They contain numerous plant remains. The basin in which Vienna lies, a hollow formed as the Alps were rising above the sea, furnishes Miocene limestones rich in marine fossils, and the sea was not driven out of this region until the middle of the Pliocene period.

The British Isles seem to have been a land area since the close of the Eocene period, with the exception of trifling incursions of the sea in Oligocene and Pliocene times. Hence denudation washed down the remains of Eocene, Cretaceous, and Jurassic strata over the general surface of southern England during the Miocene period, and some of the 'clay with flints' on the back of our chalk downs doubtless originated at that time. It is possible that the last manifestations of volcanic activity in northern Ireland and the Inner Hebrides were still in progress; but the extensive wasting of the surface must have already begun, which has stripped the basaltic covering from so much of the area and has exposed the dykes up which the lavas flowed. [G. A. J. C.]

Miocene Soils.—The 'mollasse' soils of Switzerland are usually rich in lime and highly fertile. The originating rock sometimes contains green phosphatic grains which give an analysis of nearly 40 per cent of phosphate of lime (Risler, Géologie agricole, vol. iii, p. 13). Sometimes, however, both phosphoric acid and potash are deficient in the soils, and have to be added in the form of manure. The physical conditions of the lands of the Miocene formation are not always favourable for crop production; in Touraine, for example, poor clays are widespread. In certain places nothing but conifers will succeed, and in the flats or 'bottoms', where the subsoil is composed of marl, water accumulates and peat bogs are produced (Risler, Géologie agricole, vol. iii, p. 18). The highest grounds of the 'mollasse' in Switzerland are occupied by forests, and the lower by arable and pasture lands. Cider orchards abound on this formation in the various Cantons of Switzerland, as they do on the calcareous soils of the Middle Lias and the Old Red Sandstone of England. The 'mollasse' district of Emmenthal is noted for its cheese, and that of Canton Vaud for its vineyards. [T. H.]

Miris, a genus of plant bugs, exceedingly abundant in corn- and hayfields. They have a proboscis bent under the breast for sucking, but it has not been ascertained whether they pierce the grain or live upon other insects. It is not improbable that in their larva and pupa states they are carnivorous, and in their perfect state granivorous, or at all events subsisting on the juices of plants. As soon as they emerge from the egg they run about and begin feeding, but it is not until they have attained their perfect state that they are furnished with wings, after which they can fly well. They have very prominent eyes, long antennæ and legs. Closely allied to this genus is Megaloceræa.

Megaloceræa erraticus, Linn., one of the Capsid bugs allied to *Leptoterna dolobrata*, is abundant in wheatfields from the beginning of July till late in the autumn; it is also common amongst grasses; it is narrow, and three and a

half lines long, of a straw colour; the antennæ and legs more ochreous, long and slender, the former black at the base and apex; the thighs spotted with black, and there is a broad slate-coloured stripe from the nose to the extremity of the wings when they are closed.

M. TRITICI, Kirby, is apparently only a pale variety of the foregoing. It is very common in wheatfields, from earing to harvest time. [J. C.] [F. V. T.]

Miscogaster cinctipes of Walker is a minute parasitic fly, of the family Chalcididæ, which lays its eggs in the larvæ or pupæ of *Drosophila flava*, when feeding between the cuticles of turnip leaves. The wings only expand one line and three-quarters; it is blue-green, thickly punctured; the antennæ are flail-shaped, black, ochreous at the base; abdomen not larger than the thorax, oval, glossy metallic green; legs ochreous, thighs green, except the base and tip; middle of shanks rusty; feet dusky, base of segments whitish, fifth joint black. [J. C.] [F. V. T.]

Missel Thrush, or **Storm Cock** (*Turdus viscivorus*). — This, our largest native thrush (11 in. long), is distinguished from the song thrush by its paler breast and white streaks on its wings. It is common in the wooded parts of the United Kingdom, commonly building its nest in the fork of a tree, some 10 to 12 ft. from the ground. This structure is completed by the end of February, and consists of a framework of twigs and lichen, plastered inside with mud, to which is added a lining of grass. The four greenish eggs are marked with red spots and streaks. In the southern part of Great Britain two broods may be reared in the season. The food consists of berries, snails, and slugs, to which some insects may be added. The species is entirely beneficial to agriculture. [J. R. A. D.]

Mist.—Water vapour is always present in the atmosphere; and it condenses as fog, mist, or rain when the state of saturation is reached. In fact there can be no clouds without dust. A dust particle is the nucleus that at a certain humidity becomes the centre of condensation of the water vapour so as to form a cloud particle; and a collection of these forms a cloud. If two closed glass receivers be placed beside each other, the one containing ordinary air, and the other filtered air, and if jets of steam be successively introduced into these, the steam in the ordinary air will be seen rising in a dense cloud, where in the filtered air the steam is not seen at all. Invisible dust, then, is necessary in the air for the formation of fog or mist. The reason of this is that a free surface must exist for the condensation of the vapour particles. The fine particles of dust in the air act as free surfaces on which the fog is formed. When the dust is increased in the air there is a proportionate increase of fog. Every mist particle, then, has embosomed in it an invisible dust particle. Dr. John Aitken has invented an instrument for counting the number of mist particles in the air. [J. G. M'T.]

Mistletoe.—This plant (*Viscum album*, nat. ord. Loranthaceæ) is parasitic on a variety of trees, particularly on Apples, Hawthorns, Limes, and Sycamores, over the greater part of Europe and in southern Britain, but not naturally in Scotland or Ireland. It held an important place in the rites of the Druids, who ascribed a variety of magical properties to it, and it enters largely into northern mythology. It used to be esteemed medicinally, but is now excluded from the pharmacopœias. Its popularity for Christmas decorations makes it of some importance commercially, large quantities being imported, particularly from Normandy. It can be propagated by placing the seeds in notches cut in the bark of suitable trees in spring, the chief obstacle to success being the fondness of birds for the seeds. *V. cruciatum*, a red-berried kind, is common on olives and some other trees in Spain and Northern Africa. Viscum is closely allied to Loranthus, a large genus, examples of which are found in many parts of the world. [W. W.]

Mistletoe—Damage to Woodlands. — Mistletoe (*Viscum album*) in woodlands is chiefly parasitic on Poplars, Willows, Lime, Birch, Maple, Scots Pine, and Silver Fir (rarely on Oak, and never on Beech, Alder, Larch, or Spruce), where its extension and distribution are probably due to birds (especially thrushes) cleaning their beaks from the sticky seeds after feeding on mistletoe-berries. When such chance seeds germinate they sometimes manage to get their sucker-rootlet in through the bark to the wood of the branch, and then this rootlet gets overgrown by the new annual ring of wood formed, while the mistletoe plant produces its young tough leathery foliage outside; and as new suckers (*haustoria*) are produced which extend sideways into the wood, the branch swells and the mistletoe also grows outwardly in size, and forms the well-known bushes with yellowish-green persistent foliage and white berries in winter. When the mistletoe dies, the suckers soon rot, and the infected part is riddled with holes, extending sometimes to a depth of 4 in. Infected branches usually die soon after the mistletoe decays, but when the stem is attacked (as in Scots Pine and Silver Fir) the timber is spoiled at that part. The only way of preventing the spread of this parasite is to prune off infected branches and thin out infected stems. [J. N.]

Mites.—These animals are minute Arachnoides, varying from $\frac{1}{100}$ to $\frac{1}{20}$ in. Generally they may be described as having the head-thorax, or *cephalo-thorax* as it is usually called, merged or fused with the abdomen; and in fact the whole animal is unsegmented and might be termed a sac with legs, of which there are three pairs in the young state and four in the adult or mature stage. Many different families are included under this general term, of which the Tyroglyphidæ are the most numerous as regards individuals, although not in species, and are of great importance and interest because they force themselves under our notice as they are very destructive to stored goods; we have only to note the common cheese mites, *Tyroglyphus siro* and *longior*, which occur in large numbers where cheese is stored. These species and others, such as *Aleurotius farinæ*, *Carpoglyphus anonymus*, &c., attack

grain, flour, hay, as well as other dried vegetable substances; samples have been cut from haystacks, *in which the living mass of mites was of greater weight than what remained of the hay. As a rule these animals do not attack green stuffs,* but will attack any stored bulbs, such as tulips, hyacinth, turnips, or mangels, also dried fruit, and even certain drugs, as cantharides, confection of senna, &c. Certain species have been known to live in the inside of wine bottles, floating on the surface of the wine on fragments of cork.

Glycyphagus domesticus infests houses at times, and once it has got a lodgment is most difficult to remove, as it seems to be able to resist all sorts of washes and fumigations.

Another family, the Sarcoptidæ, comprises the various species which cause so much irritation and annoyance to man and animals. The general term 'itch mites' is applied to them. Good examples which may be mentioned are the *Psoroptes communis* (common sheep scab mites); *Sarcoptes scabiei*, the mites which are the cause of itch in man; and *S. canis*, which again cause the well-known mange in dogs.

PHYTOPTIDÆ are the well-known gall mites, of which the Common Black Currant Mite is a good example. These mites cause an irritation to the young leaves; the buds swell abnormally and become very rounded. When the mites are numerous, neither the leaves nor flowers will develop. The buds do not open, and although they may retain their green colour, after a time they shrivel up and become brown. Even where there are only a few mites, if the buds open the leaves will be very much dwarfed.

The TROMBIDIIDÆ, known as Harvest Mites, are very troublesome in the young state to man and various other animals. The animal, commonly called 'red spider', is one of these mites which lives in numbers under leaves.

The IXODIDÆ, or Ticks, are mites of a larger size which are very irritating to man and animals; they bury their proboscis in the flesh, and are at times very difficult to remove—in fact, often the tick will have to be cut out.

[J. J. F. X. K.]

Mixed Farming. See under FARMING, SYSTEMS OF.

Mixed Woods and Plantations are on the whole preferable to pure woods and usually produce the largest dimensions and best class of timber, except where the soil and the situation are of a nature distinctly indicating one given species of tree as preferable to any other and most likely to thrive in large homogeneous masses. It is nature's method in great virgin forests, where the different kinds of trees usually occur either scattered more or less sporadically, or else in large or small family groups, except where some fortuitous circumstances connected with the production and distribution of seed, reproductive power, endurance of shade, hardiness, or peculiarities in soil (especially as regards moisture) and situation have enabled one species to become more or less dominant over large areas, to the suppression of other kinds of trees less able to assert their position and maintain themselves under the given conditions. The vast forests of tropical and subtropical India are almost everywhere mixed, and *even in Burma alone there are over 1500 different species of woodland trees, very few of which are to be found forming pure forest to any great extent.* Throughout the forests of Continental Europe there has during the last hundred years or more been a decided tendency to encourage the artificial growth of pure woods of several kinds of trees (especially conifers, the most profitable timber crops). But in place of this leading to the monetary advantage expected, it has only too often led to greatly increased damage and loss of money owing to insect attacks, fungous diseases, windfall, snowbreak, &c. This has especially been the case with Spruce in Germany, where pure Spruce woods grown at sixty years' rotation on a fresh soil and in a humid climate were calculated to be the most profitable form of timber crop. So now the formation of mixed woods is receiving far more favourable consideration than thirty or forty years ago, and so far as possible endeavours are being made to provide for good mixed woods in future generations. But the production of the most valuable hardwoods (Oak, Ash, Elm, Maple and Sycamore, and also Larch) has always been found to be most satisfactory in mixed woods of broadleaved trees, and especially when the chief species numerically is Beech, whose thick fall of dead foliage rich in potash forms the finest woodland humus or leaf mould. The advantages of mixed woods are—a thick crop well protecting the soil, the production of larger and finer timber, diminished danger of windfall, snowbreak, insects and diseases, easier natural regeneration, and easier introduction of changes effected by market demand, and greater picturesqueness and diversity in foliage tints; while the main objection is that they need more careful tending. The essential points to be observed in forming mixed woods are: (1) that the soil and situation should be such as will suit the kinds of trees intended to be mixed; (2) that the mixed crops should be such as can adequately protect the productivity of the soil by guarding it against loss of moisture through insolation and exhausting winds, and against becoming overgrown with weeds through too open a leaf canopy overhead; and (3) that during all stages of growth each of the different species intermixed should be able to have sufficient individual growing-space to provide for the proper expansion of its crown of foliage and its root-system, and more especially when the several trees are approaching their normal maturity. The old British system of forming mixed woods geometrically according to a stencil-like 'planter's diagram', or in alternate rows, &c., is not a sound system to go on, as it gives no consideration to changes occurring in the soil and the situation. These can only be properly taken into account when variations in the composition, depth, moisture, and other physical properties of the soil are noticed and provided for by judicious admixture of the various kinds of trees individually, or in small patches or groups of varying size, according to the circumstances of each case and the local market for timber of different kinds. A regular

survey of the land to be planted should be made two or three years before planting begins, so as to estimate the number of plants of each kind wanted and provide them from the nursery. The size of such groups may well vary from a small area up to many acres in extent, and the foliage effect of such mixed woods will at all seasons of the year be far more pleasing than can be produced by pure woods. [J. N.]

Mixing of Manures. See MANURES, MIXING OF.

Molasses as it comes into use in agriculture is of two principal kinds—cane-sugar molasses and beet-sugar molasses. In either case the molasses is the crude syrupy liquid remaining after the sugar is crystallized out of the concentrated juice. According as the impurities in the juice are greater or less, so will there be more or less molasses obtained. For every ton of sugar produced there are from 5 cwt. to 7 cwt. of molasses obtained. Cane-sugar molasses differs in several respects from beet molasses. The former is pleasant-smelling and free from any bitterness of taste, also being, as a rule, of lighter colour. It contains about 47 per cent of crystallizable sugar (sucrose), 20 per cent of 'invert' (non-crystallizable) sugar, and comparatively little mineral matter, salts of the alkalis potash and soda being present in but small quantity. Beet-sugar molasses, on the other hand, is dark in colour, has a pungent odour, and an acrid taste. While containing more actual sucrose than cane molasses, it has practically no 'invert' (non-crystallizable) sugar, and further contains a high proportion of mineral matter, this latter being largely composed of saline bodies, salts of potash and soda, which give to the molasses a laxative effect when fed freely to stock.

The following comparative analyses show the composition of cane-sugar molasses and beet-sugar molasses respectively:—

	Cane Molasses.	Beet Molasses.
Cane sugar	48·0	50·9
Invert sugar	18·0	1·1
Extractive matters	1·5	16·1
Mineral matters (ash)	1·4	12·9
Water	31·1	19·0
	100·0	100·0

Cane molasses thus contains a considerable amount of 'invert' sugar, whereas beet molasses has hardly any. The beet molasses, however, contains other bodies, such as raffinose and aspartic acid, and the proportion of salts in it is usually from 10 to 14 per cent, whereas cane molasses has little of these. The mineral matter, or ash, of beet molasses consists principally of carbonate of potash, carbonate of soda, and chloride of potassium, with some sulphate of potash and a little lime.

Molasses is much liked by stock, and is useful, not so much from its directly fattening qualities (though these are not to be passed over), but because of its sweetness and the readiness with which, in consequence, it is taken by stock. In this respect cane molasses, though the dearer article, is decidedly superior to beet-sugar molasses, and chiefly because it does not possess the objectionable properties which beet molasses has, through the presence of saline constituents in considerable amount. The great spread of sugar-beet cultivation on the Continent is responsible for the putting on the market of large quantities of beet molasses, and many have been, in consequence, the endeavours to utilize this by-product of sugar manufacture for the purposes of cattle-feeding.

The principal use of molasses, as such, on the farm is for the purpose of imparting a relish to dry fodder such as straw chaff. It is found that if molasses be mixed with water and poured over chaff, cattle will take the latter far more readily; and in the case of hay that is not quite good, or of dry chaff of inferior quality, the addition of a little molasses will cause cattle to eat it up with apparent relish. It is thus possible to utilize inferior material; and when store stock are kept and have to be carried on through the winter on an economical diet, the addition of a little molasses to their dry food will greatly assist in inducing them to take a good bulk of comparatively poor food. Also, when roots are scarce, molasses will to some extent supply the want. A common practice is to chaff a quantity of straw, or of this and poor hay, and to pour over the heap, overnight, molasses diluted with about an equal quantity of warm water. The whole is mixed up, and the heap turned over several times. The straw and chaff are softened in the process, a slight fermentation sets up just as is the case when pulped roots are mixed, overnight, with chaff, and the dry material is rendered more palatable and also more digestible. Similarly, when an animal is 'off its feed', the giving of a little molasses with its other food, or the employment of one of the many preparations purchasable, the base of which is molasses, will often induce a sickly or delicate animal to eat. This is the great use of molasses, and more important than its employment as a direct fattening material, though sugar, as is well known, is a distinctly fattening material.

Considered as a food, molasses has practically to be taken from the point of it being a material supplying soluble carbohydrates (sugar), the amounts of albuminoids and ash constituents being negligible as regards food value. Molasses is largely incorporated in compound feeding cakes, and gives to them the sweetness of taste which they possess, supplying thereby the place of locust-bean meal. When beet-sugar molasses has been used in these cakes it is generally seen in the dark colour which such cakes possess, cane-sugar molasses imparting a much lighter colour to the cake or meal used.

Of late years a great variety of foods has been brought on the market, the object of one and all alike being to utilize the surplus stock of molasses by incorporating it with some absorbent material that will hold the molasses well. Of these the best known are 'Molassine Meal' and 'Molascuit'. The former consists of beet-sugar molasses absorbed in the fine dust obtained from the preparation of peat-moss litter; and, unsavoury though it would seem, and pungent though it smells, and though doubts may fairly be thrown on the advisability of using

such a material as peat moss as a 'food' for stock, there can be no question as to the avidity with which it is taken by stock of all kinds. It has its origin from the beet-sugar districts in the north of Germany, but is now made in this country as well. It is a black-looking material, capable of ready distribution over other food, and, as sold, generally contains about 35 or 36 per cent of sugar. The other material, 'Molascuit', is a cane-sugar-molasses preparation, the absorbent substance being the pith of the sugar cane. The residue left from the cane when the juice has been pressed out is termed 'megass', and was formerly used for fuel. Now, however, the inner portion, or pith, is removed, and only the stalk burnt. The pith is dried and ground, and then used for soaking up the molasses. It is reckoned to take up about four times its own weight of molasses, and the prepared food 'Molascuit' generally contains, when put on sale, 20 per cent of the fine pith and 80 per cent of molasses. It is sold on a basis of containing 50 per cent of sugar. The preparation of this material has been very advantageous to the West Indian sugar-cane planter, who is able now to use up, by this means, the two waste products he has at hand, viz. the molasses and the expressed cane. It is maintained in regard to 'Molassine Meal' that the humous matter of the peat neutralizes the alkaline properties of the saline matters contained in the beet molasses, and so counteracts the tendency which these salts would have to produce 'scouring'. On the other hand, as regards 'Molascuit', it is pointed out that the molasses used, being from cane sugar, is superior, and not open to the objections that could be urged against beet molasses, while it is also maintained that the pith or 'megass' is itself digestible to the extent of 75 per cent, and thus makes a better feeding ingredient. The truth would seem to lie in the fact of both of the materials—peat moss and sugar-cane pith—being useful mainly because of their powers of taking up the molasses and holding it in convenient form, rather than because of any intrinsic feeding values they possess. The following are comparative analyses of good samples of the two preparations:—

	Molassine Meal.	Molascuit.
Water	24·37	15·75
Oil	·73	·63
[1] Nitrogenous matters	8·25	2·25
Sugar	36·44	50·68
Digestible fibre, &c.	16·04	17·59
Woody fibre	6·63	6·30
Mineral matter (ash)	7·54	6·80
	100·00	100·00
[1] Containing nitrogen	1·32	·36

In these analyses it should be pointed out that the nitrogenous matters, not being true albuminoids, can be considered of but little feeding value; more especially is this the case with the 'Molassine Meal', the nitrogen being derived almost entirely from the decomposed vegetable matter comprising the peat. Similarly, the oil is of but little account, and the practical value turns upon the quantity of sugar taken up.

The difficulty previously experienced in the utilization of molasses was the need of a ready means of transporting it. If sent over by itself it had to be shipped in tins or in close-fitting cases, and when brought on the farm was not capable of being conveniently distributed. The plan of obtaining it in a solid form and as a powdery material, capable of being packed in sacks and of being easily stored on the farm and dealt out to stock in handfuls as required, had very material advantages. A further impetus to the sale was given by the abolition of the import duty of £1 per ton levied on molasses when brought to this country. This relief was given subject to the provision that the molasses be used as cattle food only.

The great desideratum in the preparation of these and similar materials is that they be obtained in a condition in which, without being liable to 'heat' in transit, they shall be sufficiently powdery and free from 'over-stickiness' to allow of their ready distribution over other food. A handful thrown over dry food will often cause the latter to be more freely taken. Cattle and horses are the stock to which these foods are principally given, though it is alleged that sheep and even pigs will take them well.

In addition to the foregoing there are several other preparations of molasses, some of them of beet-sugar and some of cane-sugar molasses. In these, meals of various kinds and different refuse materials are utilized as absorbent bodies. Among such materials are the following: maize meal, rice meal, rice husk, earthnut meal, chopped lucerne hay, dried beetroot pulp, bran, dried grains, malt culms. [J. A. V.]

Mole (*Talpa europæa*), a widely distributed old-world insectivore, ranging from Scotland to Japan. It does not occur in Ireland, however, nor in the Hebrides. Among its structural peculiarities we may note the following: the fore feet are turned outwards, bear strong nail-like claws, and have an extra 'sickle bone' on the inner side; the short velvety fur has its hairs set vertically, not turned backwards; the eyes are very small, half-hidden by the fur, and have an imperfectly finished lens and somewhat degenerate optic nerves; the snout is pointed, mobile, with a bone at the tip; the tail is short, the external ears are absent, there are forty-four (in the adult forty) sharp teeth. The usual length of head and body is 5½ in., the tail 1⅜ in. more. Colour varieties are not uncommon, including albinos. Although the eye cannot form more than a blurred image (if one may argue from the state of the lens), moles bite quite deftly at a dangled worm. The senses of smell and hearing are very acute.

As to habits, the mole is capable of swift movement underground; and this is of course correlated with the fact that the body offers a minimum of friction, and that the fore limb and the pectoral girdle are most effectively adapted for burrowing. It is a very active animal and requires large and regular supplies of earthworms, slugs, and insect larvæ. The runs or underground galleries round its habitation or nesting-place facilitate its hunting, but their symmetry has been greatly exaggerated. In

winter the mole, which does not hibernate, goes far down after earthworms, and it must be noted that it can work backwards and forwards without throwing up a molehill. Ritzema-Bos reports finding winter stores of earthworms, which the mole had decapitated so that they lay inert and yet fresh! Moles seem to require to drink frequently, and often make passages to water-pools in the vicinity of their fortress. They swim very effectively.

Males are said to be more numerous than females, and the desperate combats of males are thus intelligible. They pair early in the year (usually in March); a dry nest of leaves and fibres is made (often along with others) beneath a large molehill; after a gestation of uncertain length (one to two months), four or five young are born—naked and blind. Most litters are found in May. The young are able to follow their parents and their trade in about five weeks.

As to the pros and cons of destroying moles, it will be admitted that they are out of place on a croquet green or a lawn, not to speak of a golf course; it must also be admitted that their hills are apt to spoil the reaping machine, and that their holes may be pitfalls for horses. It is a pity, however, to make such a mountain of a molehill that attention is diverted from the fact that moles kill enormous numbers of injurious grubs and slugs. Their natural enemies are weasels, owls, and buzzards, and if these were left alone the moles might be left alone too. For useful as earthworms are, there are plenty to spare. In making a hillock the mole pushes up the earth with its nose, and this usually means that the mole is feeding. There are many well-known facts in regard to moles that have not been quite clearly interpreted, *e.g.* why a tap on the snout should kill them, and why they should decompose so very quickly. [J. A. T.]

Moles in Nurseries.—The Mole (*Talpa europæa*) is a very useful little animal in nurseries, as it helps to keep down vermin (mice and voles, insects and grubs, or snails), and is seldom to be found where these are not in the soil. It quickly increases in numbers by producing young broods of three to five twice a year (May and August), and should be protected as a benefactor, and not destroyed as if an enemy. [J. N.]

Mole-catching.—The Common Mole is seldom seen above the ground, though the extraordinary amount of damage that it does through its upheaval of the soil during its subterranean wanderings in search of food, is a fact well known to almost every farmer and horticulturist. Acres of seedling cereals are not uncommonly ruined in localities where moles are prevalent, which is particularly the case in certain fen lands. If a mole is placed upon the surface of the ground it will begin to work into the ground with its snout and feet almost instantaneously, and it is wonderful how quickly it will bury itself and form a network of underground tunnels. The snout, the closely-set velvety fur, the tiny eyes, and the feet are all specially modified for an underground existence; whilst the Star-nosed Mole (*Condylura cristata*) of North America has an additional advantage for digging in the peculiarity of its nose (snout), which is encircled with a number of sensitive projections.

The mole's greatest enemies are man and inundations, more especially the latter, through which large numbers often perish. Flooding of the land where moles are prevalent constitutes one of the most effective means of keeping these pests in check, otherwise their fecundity would often lead to more serious trouble. A loose friable soil is one best adapted to the workings of a mole, and in such it usually finds the most worms, insects, and grubs, upon which it chiefly lives.

Moles are usually most active just before it begins to rain, and throw up hillocks at this time, also before a thaw in winter. During the dry weather the mole burrows deeper into the soil in search of its prey. Pairing takes place in the spring, and the female has usually four or five young at a birth, succouring them for five or six weeks. The mole reaches maturity when it is about sixteen weeks old.

The 'retreat' or 'fortress' of the mole is usually beneath the roots of a tree, hedge, or wall, and the female lines her nest with grass, dried leaves, &c. In the centre of the hillock is the nest, and from this tunnels radiate in all directions. The inner circle has several openings into an outer circle, and this into another circular passage, from which outer roads (tunnels) radiate in innumerable directions. The roof and the tunnels are all beaten closely so as to be firm, they thus help to keep the fortress dry within. The nest is at a higher level than the runs, so that this facilitates dryness of it, whilst the latter also assists in drainage of the abode.

The mole-catcher is an indispensable member of the community in those localities notorious for the presence of moles, and it is the most economical plan to employ such whenever these pests become troublesome. The baiting, setting, and collection of the spring traps demands constant attention, otherwise reproduction will exceed that of destruction, consequently no permanent good results. Good spring mole traps—the japanned ones being preferable—can be obtained from any ironmonger's for about 5*s.* 6*d.* or 6*s.* 6*d.* per dozen; and if the moles are numerous, at least half a gross of these traps should be purchased, and set in the tracks of the most recent runs.

In setting the traps, the latter should be sunk well into the newly-made burrows just before rain, say in the evening, and then visited on the following evening. The trapped moles are removed and the spring traps re-set, particular notice being taken of fresh upheavals. Moles may sometimes be dug out with a spade; but as their sense of hearing is very acute, the spade has to be wielded very dexterously at the seat of fresh boring. Some mole-catchers are very clever in the destruction of moles, and the remuneration to such affords a contributory means of livelihood, supplemented as a rule by that of rat-catcher, warrener, &c., or some other minor form of rural occupation. [F. T. B.]

Mole Cricket (*Gryllus gryllotalpa*), though mostly carnivorous, destroys seedlings in nurseries when making its finger-broad runs, as it

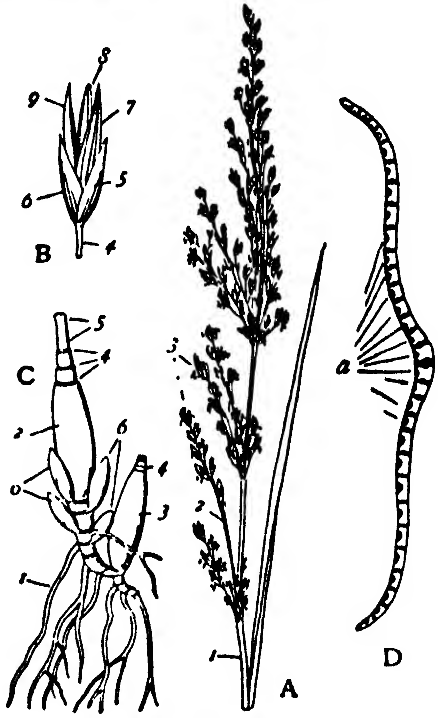
bites through all the rootlets met in its way. Seedbeds of Pine and Spruce are sometimes badly damaged thus. Their nests should be hunted up in May and June to destroy their pale-yellow eggs, generally laid from 3 or 4 to 9 or 10 in. deep, and thus prevent hatching out in July. Or petroleum and then water can be poured into the air-holes made in their runs; when touched by the oil, the crickets come to the surface and can then be caught and killed. [J. N.]

Mole Drain. See MOLE PLOUGH, also DRAINAGE.

Mole Plough.—Mole ploughs are used to form channels in the subsoil to drain the land. The channels are formed by a mole or steel cone carried on a coulter attached to a stout wheeled frame, and which is sunk into the ground to the desired depth and then drawn through the soil, leaving an open track below ground. It is obvious that stiff clay soils respond best to this treatment, as there is less likelihood of the soil falling into the channel and blocking the water. On such soils valuable work is done at comparatively small cost. When first used the plough was drawn by horses direct, or by a windlass, but steam traction is almost always employed now. The plough frame is mounted on high hind wheels and low front wheels, and the mole is rigidly suspended from a stout beam, means being provided for regulating the depth of the bore according to surface inequalities, so as to keep the channel from undulating. Land lying on a fair incline is best adapted to this form of draining, as the rapid flow of water tends to keep the channel open. The work is most conveniently done when the subsoil is soft from the presence of moisture. [W. J. M.]

Molinia is the name for a genus of grasses of which one species is common, namely *Molinia cœrulea*, known popularly as Purple Molinia, Blue Moor Grass, and Flying Bent. This species is common on moors where the land is moist rather than wet, preferably on clays, loams, and peat, often forming the bulk of the herbage. Its common associates are the Sedges, for example the Pink-leaved Sedge (*Carex panicea*); also Brown Bent Grass (*Agrostis canina*), Quaking Grass, Purging Flax, Tormentil; and insectivorous plants such as Sundew (Drosera) and Butterwort (Pinguicula). The Molinia forms tufts of herbage which is bad and unhealthy for stock. There is little nutriment in the accessible parts, for it is the habit of this plant to store its food-stuffs in an underground swollen internode. The herbage cannot be healthy, for it is usually infested by parasitic fungi, such as rusts, developed from spores (*æcidiospores*) produced on orchids. Besides, the storing underground base of the shoot is often quite full of maggots; and the ear itself often falls a prey, sometimes to the Bunt fungus (*Tilletia*), and sometimes to the Ergot fungus (*Claviceps*). The herbage of Molinia is easily recognized by the bluish colour, due to a surface coating of wax, by the basal portion of the leaf-blade becoming narrower towards the sheath, by the presence of a tuft of hair instead of a membranous ligule, and by the characteristic swelling towards the underground base of the [illegible] leaf-blade is flat, but has the habit of rolling up whenever water is scarce. This is due to a peculiarity in the structure of the upper surface of the blade: all along the upper surface there are special sets of cells (*bulliform cells*) which act as hinges, swelling up when water is plentiful, and collapsing when there is scarcity.

Purple Molinia is one of the latest grasses to produce straw and ear; the ear-bearing straw is



Purple Molinia (*Molinia cœrulea*)

A, Ear. B, Spikelet before flowering, magnified. 1, stalk of ear; 2, erect branch from main axis; 3, spikelets in flower; 4, stalk of spikelet; 5, lower glume; 6, upper glume; 7, lower pale for first flower; 8, upper pale for first flower; 9, lower pale for second flower. C, Underground parts. 1, cord roots; 2, storing internode at base of straw; 3, storing internode remaining from previous year; 4, short internode as at base of straw from which the leaves have been removed; 5, base of straw; 6, buds for making new shoots. D, Transverse section of leaf, magnified. a (upper surface), the cells which act as hinges for opening and closing the blade; the circles within the blade represent the vascular bundles, the accompanying dark portions represent the fibrous skeleton.

erect, and from 1 to 4 ft. high according to the suitability of the environment. The straw is a slender wiry cylinder with no knots, since the three leaves which it bears all originate quite close together at the very base. On account of the fineness, wiriness, and absence of knots, these straws are cut and made into bundles, sold for cleaning out pipe stems. According to Stebler, the straw forms excellent litter, and in Switzerland the grass is sometimes specially cultivated for this purpose. The base of the ripe straw behaves in a very peculiar manner: instead of becoming firm and hard, it softens and decom-

poses just above the point where the leaves are inserted, so that the first breath of wind carries it away. Ultimately the straws may accumulate in open drains and completely choke them. This peculiarity has given rise to the name Flying Bent.

The ear is a close panicle with the branches from the main axis standing erect, and bearing spikelets with usually two or three flowers, each enveloped in a purplish husk of palea.

If we would reduce the produce of Molinia, it is advisable to improve the drainage so as to render the environment less suitable; dressings of phosphate and kainit should also be applied to favour the growth of leguminous herbage, and of nitrogenous manures to favour the growth of more valuable grasses. Early cutting too, before the underground storing internodes have obtained their full charge of food, acts very unfavourably, since the buds for forming the new shoots are dependent upon these stores for further development. [A. N. M'A.]

'Monday Morning Disease.' — This is the popular designation for lymphangitis. See the article under that heading.

Mongrels, the hybrid progeny of two different varieties of the same species. The term is oldfashioned and of little use; it dates from the time when there was a widespread belief in the absolute distinctness of species and varieties, when much was made of the fact that crosses between species are usually sterile, whereas crosses between varieties are usually fertile. It is now recognized that the difference between species and varieties is relative not absolute, of degree and not of kind, for varieties are possible species in the making. Moreover, as Darwin pointed out, there are mongrels (crosses of *varieties*) that are sterile, and hybrids (crosses of *species*) that are fertile. Sometimes the word 'mongrel' is used simply to designate the progeny of a pure-bred animal with another of no pedigree. See BREED, HYBRID, SPECIES. [J. A. T.]

Monkey Nut. The popular name for the fruit of the Earthnut or Peanut, a leguminous plant of the Tropics. See EARTHNUT.

Monkey-puzzle Tree. An evergreen tree with hard sharp-pointed leaves, also called the Chile Pine. See ARAUCARIA.

Monkshood. This poisonous plant is described under its botanical designation ACONITE.

Monocercomonas gallinae, a minute protozoan animal, one of the Infusoria or Tailed Protozoa, which occurs in the white diphtheritic growths in fowls' mouths. The affection caused by the micro-organisms is distinguished from true diphtheritic roup by the exudate being only slightly attached to the mucous membrane. The part they play in the economy of such diseases has yet to be traced. [F. V. T.]

Monomorium pharaonis (the Small Red House Ant).—This minute red ant invades houses in the south-east of England and in London. It is very abundant where it occurs, and so causes much annoyance by seeking out jams, sweets, and all sugary stores, and spoiling them. The wingless worker is the caste usually seen; it is reddish-yellow in colour, less than $\frac{1}{16}$ in. long. The abdomen is smooth and shiny, but the rest of the body is dull. It forms its nests in dwelling-houses, being a purely household insect. It is an introduced or foreign ant which is, unfortunately, spreading. When once they take up their abode in a house it is difficult to get rid of them. All we can do is to trace them to their nest in some wall, floor, eave, or crevice, and fumigate them with sulphur through the entrance hole several times. [F. V. T.]

Mont d'Or Cheese.—The Mont d'Or is now very extensively made throughout France, although formerly its manufacture was confined to a district near Lyons. Originally it was the product of the milk of the goat, but now it is made from the milk of the cow. The Mont d'Or is a small, soft cheese, with a yellow crust and a creamy interior, and having a flavour which is highly relished by large numbers of French people. It is, unlike many varieties of soft cheese, quickly ripened, taking about a week in summer, and slightly more in colder weather. It is not only made from pure milk, but from the mixed milk of morning and evening, the former having been deprived of its cream. In this case the rennet is added to the milk at a temperature of 90° F., but where made from new milk, 85° F. is adopted. The curd is ready in from two to two and a half hours, the vessels in which the milk is placed holding about 5 qt. each, a fact which should be remembered, inasmuch as the smaller the quantity of milk the greater the need of control of temperature. In some cases modern jacketed vessels are used, so that the whey can be drawn off—as in the case of the Cheddar cheese, for example—after cutting, which is performed with a wooden knife. When cut, the curd is left for a while to drain, the whey being removed either by dipping or by a tap beneath. When sufficiently firm it remains at the bottom of the vat, from which it is removed and placed in the moulds, which are circular, about 5 in. in diameter by 3½ in. high. The curd while in the moulds is lightly pressed, a weight being placed upon a disk of wood, or follower, for the purpose. While still in the moulds the cheese is turned about every two and a half hours. At the end of twelve hours they go to the draining shelf, where they are turned again until ready for the drying room. The apartments in which the setting of the milk and the drainage of the curd is performed should be about 67° F. When removed to the drying room, or *séchoir*, the cheeses are taken from the moulds and placed upon dry clean straw, sometimes upon what the French term *claies*, which will carry several cheeses, and which are made of willow and straw-covered. Here they are again turned from time to time, the intervals being about three hours. Each time turning takes place they are rubbed with a solution of sea salt, while the colour of the crust gradually changes. A Mont d'Or cheese weighs about 5 oz., but much depends upon the quality of the milk; the larger the percentage of fat the greater the weight, owing as much to the retention of a larger quantity of water as to the increase in the weight of curd. In the process of draining, each mould is kept apart from its neighbour on shelves which are

slightly sloping from one end to the other. These shelves are grooved, so that the whey as it leaves the curd passes to the lower end and drips into a vessel placed to catch it. The width of the shelves is about 60 in., five shelves being usually placed together, one above the other. [J. Lo.]

Moon Blindness, a disease of the eye, due to some hereditary constitutional predisposition and not the bad atmosphere of ill-ventilated stables. See Blindness. [H. L.]

Moore, Sir Jonas, F.R.S., Mathematician and Surveyor-General of His Majesty's Ordnance, was born at Whittle, in Lancashire, in the year 1617. His chief agricultural works are: History or Narrative of the Great Level of the Fens called the Bedford Level—in which he describes its draining and surveying—and England's Interest; or, The Gentleman and Farmer's Friend. In this latter work he advocates the planting of the vast areas of waste land in the country with fruit trees for the production of cider and perry. He expatiates at length on the profits to be realized from the establishing of an industry founded on the manufacture of such wholesome, home-made drinks, which he maintains are equal to the best wines of France and Spain. Much of this book is occupied with a description of the best methods of raising fruit trees, brewing malt liquors, breeding horses, bee culture, and the raising of carp in fishponds. He died suddenly at Godalming in 1679, and was buried with great pomp in the Tower Chapel. [R. H. L.]

Moor Ill, the common name for Red Water, which see.

Moorland Planting may vary greatly according to the character of the soil. When the area to be planted is a heathery waste or poor hill pasture, as in many parts of the Scottish Highlands and of Ireland, it may often be dry enough to be plantable without requiring to be first of all drained; but wherever the moorland is wet and boggy through resting on an impervious subsoil of stiff clay or moor pan it must be thoroughly drained and reclaimed before it can be expected to grow profitable timber crops. On cold soil of this latter class in its unreclaimed state, only Scots Pine and broad-leaved softwoods will grow, though never forming profitable crops. If the drier moors, mostly serving as rough pasture, are planted, a very strong growth of rank grass and weeds springs up as soon as the sheep are taken off and the area is enclosed and planted; and this strong growth of weeds, together with frequent late frosts, are the chief dangers during the next two or three years. But where the surface growth is mostly heather, planting has fewer difficulties to contend with, so long as the soil is dry. Cold inert moorland stretches have to be drained by opening good, deep ditches two or three years before planting, in order to carry off the excessive moisture and allow the moss and bog to sag and settle down. And on deep moors it is better to drain them first of all to a depth of about 2 ft. to let the moor settle gradually and gain in density, than to sink trenches to their full depth at once. But even then it is necessary to open them for about one-third deeper than finally intended to be, in order to allow for the subsidence of the moor in drying. In Britain and Ireland on moorlands of any kind notching has usually been the only method of planting; but though certainly the cheapest, it is only suitable for a light class of soil, as otherwise the roots of the young plants get bent and twisted, and the plants themselves seem to become far less capable of resisting late frosts, fungous diseases, &c. On stiff soil the use of ball-plants raised with a circular spade might be feasible if the nursery can be located near the planting area. For mountain and moorland planting the crops most likely to be profitable are conifers—Larch on well-drained land, Douglas Fir in dry and sheltered places, Silver Fir on fresh soil, and Redwood (*Thuja gigantea*) and Spruce on moister ground, Black Poplar, White Willow, and Alder on wet, but not stagnant parts. Where reclaimed mossland gives a sandy soil, most of the soft woods and conifers grow well, and sometimes also Oak and Ash. For both mountain and moorland planting it is important that the plants used should be thoroughly acclimatized before being planted out, otherwise they are apt to be badly damaged by late frost and fungous diseases. If seedlings and transplants are not obtainable from a home nursery, then one- or two-year-old seedlings should be got and put into nursery lines for at least one year, in order to acclimatize them to a certain extent. The cost of mountain and moorland planting may vary greatly according to amount of draining and soil-preparation required, the size of plants used and the method of planting, the amount of beating up and cleaning required, &c., so that it may range from about £3 to over £8 an acre, according to local conditions. [J. N.]

Moor Mat Grass. See art. Nardus.

Moors.—Under the term 'moors' may be included (1) those parts of the country which are uncultivated and unfit for cultivation owing to their hilly and rugged character—and very often the ungenial nature of the climate adds to the undesirableness of even attempting tillage; and (2) those parts of the country, including bogs and mosses, which lie uncultivated owing to their natural poverty or wetness. The hilly and rugged tracts that lie uncultivated are used for the grazing of sheep and cattle of the hardier breeds, and for deer forests and grouse moors. Little can be done for the direct improvement of hilly and rocky moors. By fencing, draining, and the provision of shelters they are certainly made more valuable for sheep-runs, but attempts at manuring have not usually proved very profitable. The persistent cutting of brackens and the judicious burning of heather also make moors better feeding grounds for sheep and game. Fencing and draining have been undertaken to a very great extent on many moors in southern Britain, but in the Highlands of Scotland there are still vast tracts unenclosed. Most farms, however, have outside shelters of one kind or another provided. In the absence of natural coppices, clumps or belts of trees are often planted. These, which should be at parts of the sheepwalk near good rough

pasturage which will not be easily covered by snow, act as windbreaks, and allow the sheep to graze in comparative comfort even in times of severe storm. In laying off a new plantation or in building a 'stell' (see art. STELL), regard must be had to the direction of the prevailing wind of the district.

Moorland which is low-lying and moderately level, but which has been left uncultivated owing to its natural poverty or wetness, has been the subject of many experiments with a view to its improvement. Not a little has been done by way of reclamation, and it is undoubted that drainage does much to render wet and sour tracts fit for the plough. It is on record that Lord Kames (see art. KAMES) made an interesting and successful experiment on the estate of Blair Drummond by removing and carrying off, by means of the river, successive layers of peaty matter, leaving a rich alluvial soil. 'An extensive tract of country where formerly only a few snipe and muirfowl could find subsistence, was converted as if by magic into a rich and fertile carse worth £3 to £5 per acre.'

The value of moors for grazing and sporting purposes depends much on their locality, their exposure, their liability to storm or the reverse. On the Highlands of Scotland not a few landowners have found it profitable to clear off sheep and allow deer to have undisturbed possession, and there has been a considerable demand by wealthy men — English and American — for grouse moors and deer forests in the north.

Moorland farms used for the grazing of sheep vary greatly in value. In Lanarkshire, for example, many moors have a very considerable value, carrying a comparatively large stock of sheep in proportion to their extent, and raising a good article. In many Highland districts, on the other hand, it may take five or more acres for each sheep grazed, and even with this allowance a poorer animal may be produced. In some localities the rent per sheep grazed, runs from 1*s.* 6*d.* to 3*s.*; in others it is as high as 7*s.* 6*d.* to 10*s.* The difference in the rent is accounted for, not only by the bigger and more saleable sheep that are reared, but by the expense many farmers—especially in the Highlands—incur in wintering away a great proportion of their young sheep, and also by the excessive losses which are almost every year sustained in many stormy and exposed districts. [W. B.]

Moose. See ELK.

Morbihan Cattle, the black-and-white cattle of Brittany. See BRITTANY CATTLE.

Morinda citrifolia, Linn., nat. ord. Rubiaceæ—the Indian 'mulberry' or Togari wood.—Some few years ago the cultivation of this tree, in the form of a bush, was an important branch of agriculture and an exceptionally profitable one. It was grown on account of its roots, from which a rich red dye, known as *al*, was prepared. Within the past few years the traffic in that product has been entirely ruined through the fabrication of the coal-tar dyes, and accordingly the cultivation of Morinda in India, like that of the Madder of Europe, has been entirely abandoned. One of the most interesting features of Morinda production was the circumstance that, through special selection and adaptation, a special stock had been attained, so that a tree 30 to 50 ft. in height had been made to flower and produce fertile seed within two years, and as a bush hardly 2 ft. in height. A widespread opinion prevails in India that textiles dyed with *al* are protected against the depredations of white ants. [G. W.]

Mortgage.—A mortgage is a security upon land for payment of money advanced with interest. In form it is an absolute conveyance of the land, subject to an agreement for reconveyance on payment of the sum advanced on or before a certain date with interest, and it also usually contains a covenant by the borrower for repayment of the capital sum and interest. The person who borrows the money and conveys the land is called the mortgagor; the person who lends the money and to whom the land is conveyed is called the mortgagee. The right of the mortgagor to redeem his estate on payment of all principal, interest, and costs to the mortgagee, subsists even after the date named in the mortgage deed for payment, and is called his 'equity of redemption'. If the mortgagee desires to enforce his security he may do so by obtaining a judgment for foreclosure in default of payment by the mortgagor, the result of which, when made absolute, will be that the equity of redemption will be foreclosed, and the mortgagee will be allowed to retain the mortgaged property as his own. He has also a power of sale of the property, in default of payment after three months' notice in writing calling in the mortgage money, or if interest is two months in arrear. The proceeds of sale, after payment of the principal, interest, and costs, are payable to the mortgagor. The mortgagee may also without any legal proceeding enter into possession of the property; but if he does so, the equity of redemption will still subsist until barred by lapse of time, and he must account for all the rents and profits received by him to the mortgagor, who is entitled to the balance after payment of the mortgage debt, interest, and costs. [A. J. S.]

Mortimer, John, F.R.S. (1656–1736?), a talented writer whose name is worthily inscribed on the roll of famous agricultural writers. His memory will ever be kept green by a single work of great merit, entitled The Whole Art of Husbandry, or The Way of Managing and Improving of Land. In this book he incorporated an account of the best practices in ancient and modern agriculture, to which he added his own experiences won from foreign travel and based on the results of experiments carried out on his estate in Essex. Considering the date of publication (1707), the arrangement and subject-matter of this work are strangely modern in their tone and practical in their aim. The scope of the book is very wide. The author discourses on the enclosing of land, ditching, hedging, and draining; the management of pasture and meadow land, haymaking, and grazing; the structure of soils, the weed plants characteristic of each type, and the crops best adapted for the varying conditions. The cultural customs in different countries are intelligently dis-

caused, and reliable information is given concerning the practices of liming, chalking, marling, and the application of several manures. Hop culture is treated in a satisfactory manner. Several chapters of the book are devoted to the live stock of the farm, the systematic treatment of which won the admiration of Donaldson, who said of the book that it marked a great advance in the progress of agricultural literature from preceding authors. Fishponds, orchards, the culture of silkworms, and the making of cider are all discussed in the pages of this remarkable work. The Countryman's Kalendar, added as an appendix, might well appear in any modern work. So much favour did Mortimer's work find among agriculturists that it was translated into Swedish by Serenius in 1727. [R. H. L.]

Morton, John Chalmers, a notable agricultural writer in the latter half of the 19th century. Born in 1821, he was the son of John Morton, agent for over fifty years to the Earls of Ducie upon their Gloucestershire estate, and author of a book on Soils. His mother was the sister of Dr. Thomas Chalmers, the celebrated divine. Mr. J. C. Morton was educated at Merchiston Castle School, Edinburgh, of which his uncle, Charles Chalmers, was headmaster. Afterwards he attended some of the University classes, and distinguished himself in mathematics. Among the classes was one for agricultural students, held by Professor Low. But before he was nineteen years old he was summoned home to assist his father in managing the Whitfield Model Farm, just started near Tortworth. There he gained an insight into the best English and Scottish farm practices. In 1844 he was chosen to edit the Agricultural Gazette, which was published in conjunction with the Gardeners' Chronicle, but afterwards brought out independently. Mr. Morton was the first editor, and 1300 consecutive weekly numbers were brought out under his supervision without a break, until his sudden death in 1888 put an end to his valuable work. He edited the Cyclopædia of Agriculture known by his name, completed in two volumes in 1855, and for a time he practically edited the Journal of the Royal Agricultural Society. For a great many years he acted as inspector under the Land Commissioners, and he served for six years as one of the three members of the Royal Commission on the Pollution of Rivers. Mr. Morton was a man of great energy, ability, and kindness, highly respected and beloved by a large circle of friends. [W. E. B.]

Mosquitoes.—Mosquitoes are insects belonging to the order of Diptera or two-winged flies, and they form a family known as the Culicidæ. They are sometimes spoken of in Britain as 'gnats'. These insects are often a terrible scourge both in tropical and temperate regions, and even in the Arctic circle they are so numerous at times as to make the life of hunters and explorers unendurable.

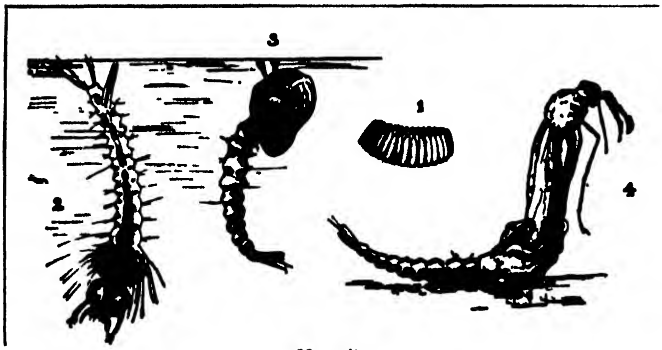
The majority of female mosquitoes suck the blood of man and animals during some period of their life if they can; some, however, are purely vegetable feeders, sucking the nectar from blossoms, the juice of fruit, &c. No male mosquitoes are known to bite. The great annoyance caused by the biting of the females is of secondary importance; it is the part the Culicidæ play in carrying certain diseases that has brought them so much into prominence in recent years. No less than 700 species have now been described, but only a few of these are known to carry diseases. A typical female mosquito has two wings, the veins of which are always covered with scales, which also form a fringe to the wings; there are normally six long veins, with a small one on the outer edge (subcostal), but in one group there are seven distinct long veins (*Heptaphlebomyia*, Theobald). The venation of the wing of the Culicids separates them from other gnats. The mouth is drawn out into a long proboscis, composed of an upper lip and lower lip, with four needle-like lancets between, two being elongated mandibles, two long maxillæ; an extra single piece is seen, the tubular hypopharynx. The lower lip does not puncture the skin when the mosquito bites, but acts as a guide for the insertion of the other piercing organs. Down the hypopharynx of this proboscis the acid saliva is forced when the puncture is made. Close to the proboscis are seen a pair of jointed processes—the palpi—they may be long or short, and vary in appearance. The palpi are useful characters to distinguish a malarial-carrying mosquito from a non-malarial agent, as will be pointed out later. In the females the antennæ are slightly hairy, but in the males these sensory organs are usually densely plumose. The body, head, and legs, as well as the veins of the wings, are typically covered with scales of varied form over all or part of their surface. These scales form useful characters by means of which the mosquitoes are classified, and by which they can easily be identified. In some the scales are reduced to fine curved hairs, except on the head and wings (Anopheles). In size, mosquitoes vary from rather more than ½ in. to about $\frac{1}{12}$ in. in length. Some, such as the Elephant Mosquitoes (Megarhinus and Toxorhynchites) of South America, India, Africa, and Australia, are most brilliantly coloured insects; the majority are of more dingy appearance, such as we see in the British species, enumerated later.

Mosquitoes in their young stages are aquatic. They breed in all sorts of collections of water, as long as it does not flow too swiftly. The edges of rivers, marshes, and lakes, small roadside puddles, even where water drips from standpipes, may contain larval and pupal gnats. Many breed in the small collections held up in cut or insect-damaged bamboos, in the water that is collected by the leaves of Bromelias, and even in the liquid of pitcher plants. Some species prefer such natural collections of water; others such artificial collections as in rainwater barrels, cisterns, tanks, old sardine tins, calabashes, and broken bottles—such are usually household mosquitoes.

Ship tanks may contain them, and in this way mosquitoes have been carried for great distances, thus accounting for the wide distribution of certain household species. A few breed in salt pans and in the sea.

The female mosquito lays her eggs on water, or on mud where it is likely to get flooded. The ova may be laid (1) separately, (2) in long ribbons, or (3) in boat-shaped masses, all of which float on the surface. The British species deposit theirs in the first and last manner. Larval mosquitoes are often spoken of as 'wrigglers'; they move with great energy in the water. They are provided with an air-taking apparatus at the tail end, which may either be in the form of a long tube or siphon, or be nearly flush with the surface of the body. The food consists of algæ and small animals, whilst some are cannibals in habits. When they want air they come to the surface and pass the openings of the air tube just above the surface film. If they cannot do this they die.

The larvæ may develop rapidly or they may live some months. The pupal stage is also active, but differs much from the larval stage. The air tubes in the pupa are two in number, and are placed on the thorax as two trumpet-shaped bodies; these also are brought to the surface for respiration. Although the pupa is active in habits, it does not take food any more than the chysalis of a butterfly.



Mosquito

1, Eggs 2, Larva. 3, Pupa or chrysalis 4, Perfect insect emerging from case.

The adult, when it hatches, uses the skin of the pupa as a raft at first, then as its wings harden it flies off. Many are destroyed by these fragile craft being blown about and upset.

The three main groups of Culicidæ are: (1) the Anophelinæ, (2) the Culicinæ, and (3) the Aedinæ.

The Anophelinæ have females with palpi as long, or nearly so, as the proboscis; and when at rest the head, proboscis, thorax, and abdomen are nearly in a straight line, hence as they settle at an angle to the resting surface they have been described as looking like a thorn stuck in the ceiling or wall.

The Culicinæ have short palpi in the females, long in the males; when at rest these mosquitoes present a humped appearance.

In the Aedinæ the palpi are short in both sexes. Other groups occur, but only the two first named are of economic importance as disease carriers. Larval Anophelines have no air tube, and when breathing lie parallel with the surface film. Larval Culicines hang head downwards and have long air tubes, which alone touch the surface film. The former prefer natural collections of water, but some, such as our spotted-winged species, occur in rain barrels, &c., out-of-doors.

The diseases with which mosquitoes are connected are the malarial fevers, yellow fever, filariasis, and dengue fever.

Malaria is now known, through the researches of Ross, Grassi, Laveran, and others, to be due entirely to transmission by mosquitoes of microscopic blood-feeding protozoa (Hæmamœbidæ). These minute parasites must pass part of their life-cycle in the bodies of certain species of mosquitoes, eventually reaching the salivary glands of the insects, and thus get ejected into the blood when the creatures bite. As far as we at present know, it is only mosquitoes belonging to the various genera of the Anophelinæ that are the means by which the forms of malarial parasites can attack man (Anopheles, Myzomyia, Cellia, &c.). The mosquito obtains the parasites by sucking the blood of a malarial subject.

Yellow fever is carried solely by the Tiger Mosquito (*Stegomyia fasciata*, Fab.). The range of this pretty black-and-white lined and spotted mosquito is very wide, it being found in South Europe, Africa, India, Australia, North and South and Central America, the West Indies, and on many oceanic islands. It is often found on board ship and in trains, and so has become widely distributed.

Filariasis is a disease due to various species of small nematode worms in the blood. These parasites undergo part of their development in *Culex fatigans*, Wied., and *Mansonia uniformis*, Theob. Neither of these mosquitoes, which pass the worms out via their proboscis into man's blood, occurs in Britain. The first is the Common Brown Household Mosquito of the tropics and subtropics; the latter occurs in Africa and India, &c.

In dengue fever *Culex fatigans* again seems to play an important rôle.

In Britain we have twenty-two native species. Two of these are known to be hosts of the malarial parasite on the Continent and in North Africa, namely *Anopheles maculipennis* and *A. bifurcatus*. The former has spotted wings, the latter clear wings. Both breed in small pools and water barrels near habitations, the latter in lakes as well. A third Anopheles occurs in Britain—*A. nigripes* (Staeg), a dark, slaty-black, clear-winged species which occurs in Scotland, Wales, Cornwall, and a few other parts of the United Kingdom.

No other known disease carriers occur in Britain. Several of the other species bite, however, very viciously. On the Norfolk Broads, a reddish-brown species with variegated wing

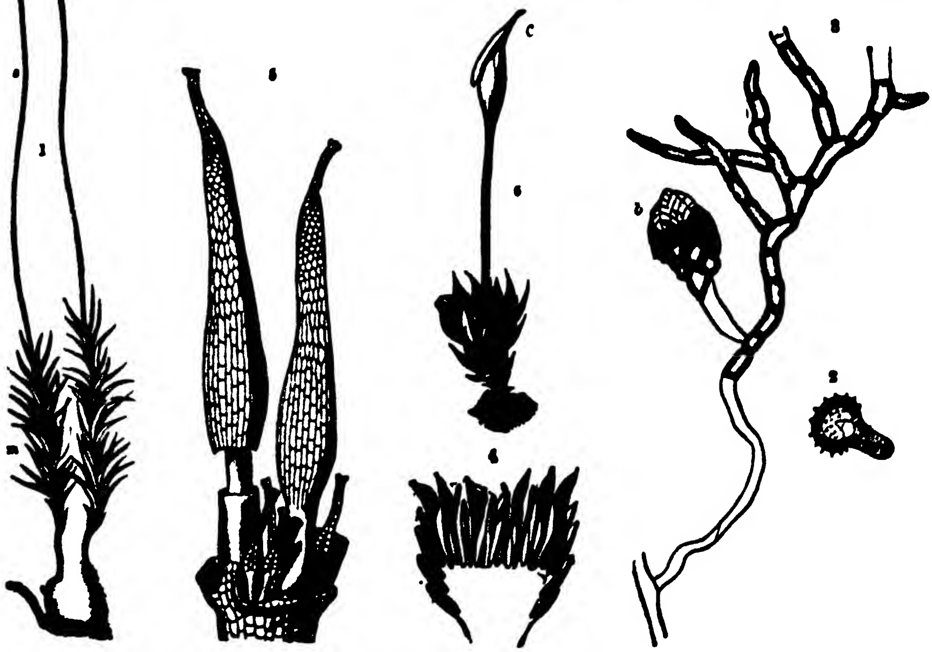
scales, known as *Tæniorhynchus richardii* (Ficalbi) is a most vicious biter. Another, common along the Thames valley, with banded legs and mottled wings, is *Grabhamia dorsalis* (Meigen). In woods one is frequently bothered by the brown-banded-legged *Culicada cantans* (Meigen), which attacks the ankles in the evening, and also by the dark-legged Wood Mosquito (*C. nemoralis*, Meigen), which some years is a great pest in Epping Forest. Serious bites, often attended by fever, are given by the Spotted-winged Culex (*Theobaldia annulata*, Meigen) in autumn, both in houses and in the open. In houses, cellars, sheds, &c., all over Britain, the Brown House Gnat (*Culex pipiens*) is only too common, and this also frequently bites man.

Sylvan mosquitoes one cannot hope to cope with, but those which are intimately connected with man's habitations can be destroyed. All superfluous standing water should be drained away, not only around houses, but around villages and towns. Larger areas that cannot be drained, and such artificial collections of water that are necessary, should either be treated two or three times with paraffin oil dabbed over the surface by means of a rag on the end of a pole, or if the latter frequently emptied. The oil forms a layer or film over the surface, and so the larvæ and pupæ cannot breathe and are killed. Small barrels, cisterns, &c., should be frequently emptied when 'wrigglers' are seen, or kept permanently covered up.

The enormous good done by killing these disease-producing agents can be seen at Havana, where yellow fever has practically been stamped out by preventing *Stegomyia fasciata* from breeding; at Ismailia, where the destruction of Anophelines has led to the great reduction of malaria; and in the much-improved conditions in West Africa, &c. See arts. CULEX PIPIENS and ANOPHELES MACULIPENNIS.

[F. V. T.]

Mosses.—The Muscineæ or Bryophytes, one of the principal orders of the vegetable kingdom, includes several families, the most important being the Liverworts or *Hepaticæ*, and the True Mosses or *Musci*. All have a vegetative body, which is green and capable of independent nutrition; this is developed from an asexual spore, and it bears the male and female organs, whereas in Ferns the vegetative body bears only asexual spores (see FERNS).



Mosses

1, Plant of a moss (*Polytrichum commune*). *m*, Vegetative plant with leaves and stem, bearing two capsules; one (*c*) with, and another (*o*) without a calyptra. 2, Germinating spore. 3, Protonema with bud (*b*) which will become a leafy shoot. 4, Tip of a male shoot, with antheridia and scales. 5, Tip of a female shoot with archegonia; two of these enlarged into a sporogonium covered by upper part of archegonium—the calyptra. 6, Leafy female shoot bearing a mature 'moss-fruit' *c*.

The vegetative body is a flattened thallus in the lower Liverworts, but in the true Mosses it consists of a branched stem bearing leaves (fig. 1). The attachment organs are not true roots, but rhizoids somewhat resembling the root hairs of higher plants. The reproductive organs consist of antherozoids or male bodies formed in hollow sacs, the antheridia, and of eggs each of which is contained in a flask-shaped archegonium

(figs. 4 and 5). In the leafy Mosses these organs occupy the ends of branches and are surrounded by leaves, so forming the 'moss flower'. The antherozoids are motile, and when liberated in drops of dew or rain are attracted down the neck of the archegonium to the egg. The fertilized egg divides, and ultimately produces the sporogonium, or 'moss fruit' (see fig. 5). This consists generally of a capsule borne on a stalk attached to and deriving nourishment from a vegetative branch. The spore capsule is of simple structure in the Liverworts, but in the Mosses is generally provided with a calyptra or loose hood, a lid, and a peristome consisting of teeth; all these are removed or opened before the spores are liberated. The anatomy of the capsule and the structure of the leaves are distinguishing characters for the families, genera, and species of Mosses. The spores are minute, and, carried as dust, they are the chief means of dispersal. They germinate under moist conditions and produce new plants directly, or, as in true Mosses, indirectly by means of a filamentous protonema (figs. 2 and 3).

Mosses occur all over the earth's surface. The greatest number of species are found in temperate regions and in moist shaded places, but on exposed mountain rocks a few Mosses grow along with Lichens. In northern and Arctic regions some species grow thickly massed together and form an important feature in certain landscapes; thus *Sphagnum* and *Polytrichum* with Lichens (see article) cover large areas of Arctic tundra and provide food for animals. Mosses hold an important place amongst pioneer plants which first cover bare soils, and by their growth and decay form cushions and hummocks of nearly pure humus; in this way *Racomitrium lanuginosum* (the Woolly Fringe Moss) may cover miles of wet moorland and afford shelter to various grasses. Mosses also play an important part in the formation of peat, especially in the earlier stages of the deposit. Certain layers of peat bogs are composed almost entirely of *Sphagnum*, *Hypnum*, and *Polytrichum*; these furnish the special kind of peat known as moss litter, which is also used in the preparation of certain cattle foods (see MOLASSES). [W. G. S.]

Moss Land, Reclamation of. See arts. BOGS, RECLAMATION OF; and RECLAMATION OF LAND.

Moss Litter. See LITTER.

Moss Litter Manure.—Peat moss in itself is probably of less manurial value than straw, for straw contains a substantial proportion—nearly 1 per cent—of potash, of which constituent peat moss contains scarcely any. Straw also contains appreciable traces of phosphoric acid, of which there is scarcely any in peat moss. On the other hand, peat moss, it is true, has a larger proportion of nitrogen than straw, but the nitrogen of straw is probably more readily available for manurial purposes than is the larger quantity found in peat moss.

Thus far we are referring to straw and peat moss merely as raw materials. When they are used as litter and made the vehicle for the production of stable manure—or farmyard manure—the initial superiority attaching to the straw itself is decidedly more than counterbalanced by the extra absorptive powers of the peat moss; so that a ton of stable manure made from well-used peat-moss litter is decidedly more valuable than a ton of similar manure made from straw.

A number of years ago, soon after peat moss came on to the market as a substitute for straw litter in stables, the writer of these notes made some comparative experiments on the absorptive power of the two articles. He found that if 1 lb. of straw chaff was thoroughly soaked in water and drained, it temporarily held 3 lb. of water, which, when what may be called the 'loose' water was squeezed out by pressure between the hands, was reduced to 2·74 lb. When 1 lb. of peat moss litter was similarly treated, it was found capable of initially absorbing more than 9 lb. of water, and even when squeezed as dry as the hands could squeeze it, it still retained 3·84 lb. of water. Having regard to the comparative apparent wetness, as well as the mere weight, of the two materials in the intermediate conditions of wetness, the conclusion drawn was that it would probably be not far wrong to say that 1 ton of peat moss litter, as a practical absorbent of liquid, would go about as far as 2 tons of chopped straw—which, of course, would be more absorbent than 'long' straw.

Experiments were also made by moistening chopped straw and peat moss litter with fresh urine, to which a few drops of decomposed urine were added to start fermentation, the soaked litter in each case being exposed to the air under like conditions for a number of days. The transformation of the organic nitrogen of the urine into ammonium carbonate was much more rapid and complete with the straw litter than with the peat-moss litter. Under the conditions of the experiments, the greater part of the nitrogen of the urine was lost by evaporation in the straw experiment, while the loss in the peat-moss experiment was but trivial. The quantity of material being small, and the exposure to the air being free, the loss of ammonia in these experiments would necessarily exaggerate what would occur in the stall or stable, much of the difference between the effect of the two litters being no doubt due to the fact that the peat-moss litter is more compact and retentive of moisture than the straw. To a certain extent this would be counteracted in practice by the consolidation of the straw manure by the feet of horses or cattle, as well as by the mere question of bulk, so that in actual practice the conditions would be more favourable to straw than they were in the small laboratory experiments. Nevertheless, making allowance for all this, the experiments were considered as demonstrating that peat moss was a much more economical absorbent of urine than straw, allowing of less rapid fermentation and less loss of ammonia subsequent to fermentation. The observation accorded very much with the now well-known fact that a stable or feeding box littered with peat moss has not the strong ammoniacal smell that is generally associated with stables littered with straw, unless the straw is

frequently changed; nor does peat-moss-litter manure, when 'made', smell of ammonia like ordinary stable or yard manure made with straw.

At the time of this investigation, samples were collected from town stables, both of manure made with straw and of manure made with peat-moss litter. The following results represent average samples, both in their natural state and, for purposes of comparison, calculated to the dry condition:—

COMPOSITION OF MANURES IN NATURAL MOIST STATE

	Stable manure made with straw (average of 3 samples).	Stable manure made with peat-moss litter (average of 2 samples).
Water	70·03	77·84
Organic matter	24·28	18·02
[1] Phosphoric acid	0·48	0·37
Lime	0·70	0·33
Potash	0·59	1·02
Magnesia, &c	1·30	1·08
Siliceous matter	2·62	1·34
	100·00	100·00
Organic nitrogen	·52	·37
Ammoniacal and nitric nitrogen	·10	·51
Total nitrogen	·62	·88
Equal to ammonia	·75	1·07
[1] Equal to phosphate of lime	1·05	·81

COMPOSITION OF MANURES CALCULATED TO DRY STATE

	Stable manure made with straw (average of 3 samples).	Stable manure made with peat-moss litter (average of 2 samples).
Organic matter	82·36	81·12
[1] Phosphoric acid	1·38	1·69
Lime	2·26	1·50
Potash	2·09	4·50
Magnesia, &c.	3·86	5·20
Siliceous matter	8·05	5·99
	100·00	100·00
Organic nitrogen	2·10	1·67
Ammoniacal and nitric nitrogen	·41	2·26
Total nitrogen	2·51	3·93
Equal to ammonia	3·05	4·80
[1] Equal to phosphate of lime	3·01	3·69

If the results are compared when calculated to the dry state—to eliminate the question of different degrees of moisture—it will be seen that the total nitrogen in the peat-moss-litter manure is roughly 4 per cent of the total dry matter, as against 2½ per cent in the case of the straw-litter manure; also that the nitrogen in the active forms of ammoniacal and nitric nitrogen is about 2¼ per cent of the dry matter in the case of the peat-moss-litter manure, and less than ½ per cent in the case of the straw-litter manure. The peat-moss-litter manure also contains more phosphates, and more than twice as much potash as the straw manure. Seeing that the straw in itself contains far more potash to begin with than the peat-moss litter, this difference must be attributed to potash absorbed from the excreta of the animals littered in the stable. There is therefore no reason for the supposition once prevailing, that well-made peat-moss-litter manure, ton for ton, is any poorer than straw manure; the contrary, indeed, being the case, owing to the more retentive and preservative character of peat moss as compared with straw. The use of peat-moss litter on the farm has the obvious advantage of enabling the farmer to use for feeding purposes the straw that would otherwise be consumed as bedding. [R. D.]

Moths belong to the order Lepidoptera and to the sub-order Heterocera. They are far more numerous and much more destructive than their close allies, the Butterflies. Moths are distinguished from butterflies by a heavier and stouter body (except in the case of some Geometers); by the antennæ, which are either feathery, threadlike, or comb-shaped, but never clublike as in the butterflies; and by the wings, which are folded over the back when at rest. The larvæ of the moths have either smooth or hairy bodies, never spiny as in the case of the larvæ of some butterflies. Some of the pupæ are naked, others are enclosed in a cocoon, while a third type is found in a cell of earth. The ravages of moths are not confined to garden or field crops, but extend to woodlands, granaries, flour mills, and stores. The following is a brief list of the more destructive species, particulars of which will be found (under their technical designations) in separate articles.—

MOTHS DESTRUCTIVE TO FIELD CROPS.—Pea Moth (*Grapholitha pisana*), Diamond-back Moth (*Plutella cruciferarum*), Cabbage Moth (*Mamestra brassicæ*), Common Dart or Turnip Moth (*Agrotis segetum*), Heart-and-Dart Moth (*Agrotis exclamationis*), Grass or Antler Moth (*Charæas graminis*), Silver Y Moth (*Plusia gamma*), Hop Snout Moth (*Hypena rostralis*).

MOTHS DESTRUCTIVE TO GARDEN CROPS AND FRUIT TREES.—Carrot Moth (*Depressaria*), Currant Clearwing (*Ægeria tipuliformis*), Lackey Moth (*Clisiocampa neustria*), Vapourer Moth (*Orgyia antiqua*), Dot Moth (*Mamestra persicariæ*), Winter Moth (*Cheimatobia brumata*), Mottled Umber Moth (*Hybernia defoliaria*), Codling Moth (*Carpocapsa pomonella*), Bud Moth (*Hedya ocellana*), Pith Moth (*Blastodacna hellerella*), Magpie Moth (*Abraxas grossulariata*), Currant Shoot Borer (*Incurvaria capitella*), Raspberry Moth (*Lampronia rubiella*), Garden Swift Moth (*Hepialus lupulinus*).

MOTHS DESTRUCTIVE TO WOODLANDS.—Goat Moth (*Cossus ligniperda*), Wood-leopard Moth (*Zeuzera pyrina*), Pine Moth (*Gastropacha pini*), Lackey Moth (*Clisiocampa*), Pale Tussock Moth (*Dasychira pudibunda*), Brown Tail Moth (*Porthesia*), Pine Noctua Moth (*Panolis piniperda*), Pine Looper Moth (*Bupalus piniarius*), Winter Moth (*Cheimatobia brumata*), Pine Shoot Tortrix (*Retinia bouliana*).

MOTHS DESTRUCTIVE IN FLOUR MILLS AND TO STORED GOODS.—Mediterranean Flour Moth (*Ephestia kühniella*), Corn Moth (*Tinea granella*), Clothes Moth (*Tinea tapetzella*). [R. H. L.]

Motive Power in Agriculture.—In modern agriculture, machines called prime movers, or power motors, which utilize the

power or energy derived from wind, water, steam, gas, oil, and electricity, are largely employed in one form or another for a variety of purposes. The application of power, other than animal power, to the various mechanical operations performed on the farm relieves the farmer of much physical labour, but demands of him, in return, the exercise of greater skill and mental *activity. It also increases the* capacity and efficiency of his work and reduces the cost. Most of the work upon the farm can now be performed by machines requiring motive power other than man power to operate them. It is therefore essential, in order that the work may be done as efficiently and as cheaply as possible, that the farmer should have some knowledge of the motive powers available for his use, and understand the operation and care of the various motors used for agricultural purposes. The selection of a motor for any given purpose is governed chiefly by the following considerations: suitability, economy, and first cost. The suitability of a motor for the work it has to do, and to the circumstances under which it will be used, having been determined upon, the next consideration is that of *economy*. The most economical motor is the one which develops and furnishes the horse-power required at the least current expense or cost of obtaining the power per unit of time. This will consist chiefly of the expenditure on motive power, repairs, stores, and attendance, and of interest, and depreciation of plant. Now wind power can be obtained everywhere and is absolutely free; consequently the windmill is the most economical of all prime movers, although its first cost per horse-power developed is greater than that of some of the others. Windmills, however, are not very powerful motors, and as they are very irregular in their action, due to the variable and intermittent character of their motive power, they are suitable only for work which permits of a complete suspension during a calm, such as irrigation, cutting feed, &c., or which permits of an accumulation or storage of energy taking place, as in the pumping of water into a reservoir, the charging of electrical storage batteries, or the compressing of air into a receiver. For purposes such as these windmills are coming more and more into favour on account of their economical character, and although they are very uncertain in their action, and at times becalmed for days together, on the average a very useful wind velocity of ten miles an hour can generally be relied upon for eight hours out of the twenty-four.

Next to wind power, water power is the cheapest kind of motive power—when it can be obtained,—but before it can be utilized some expenditure is generally required for the construction of a 'penstock' and a 'tail race', and, in addition, there is the expenditure required for the upkeep and occasional cleaning out of the same. Water motors, though not so economical as windmills, are much more steady in their action and are usually of far greater power; consequently, for most purposes, and when the necessary power is at hand, they constitute the most desirable, as they are the most economical (next to windmills) of all prime movers.

Formerly, before the vast improvements effected on the steam engine by James Watt, and when only the natural powers of wind and water and muscular energy were available for doing work, windmills were extensively used for grinding corn, pumping water, cutting feed, stamping ores, sawing wood, and for many other industrial purposes. For most of these purposes, however, wind power was first displaced by steam power, and since then the introduction of gas and oil engines and suction-gas plants, capable of developing small powers cheaply and steadily, has restricted the sphere of usefulness of windmills still more, until at the present time the latter are used only for the purposes stated above, or where fuel is difficult to obtain and costly.

Steam, gas, and oil engines are now extensively used on the farm, and petrol motors have recently been introduced with some degree of success for land cultivation, and for driving threshing machines, chaff cutters, and other farm machinery.

The motive powers chiefly utilized in performing mechanical work may be divided into—(1) Animal power; (2) wind power; (3) water power; (4) steam power; (5) power derived from the explosion of gas, vaporized oil, petrol, &c.; and (6) electrical power.

In order to compare the power or value of one working agent with another, a standard of comparison or unit of power is required. The unit of power most generally used for this purpose, called a horse-power, was first introduced by James Watt. In order to define this unit, Watt made some experiments on the strong horses employed by the brewers in London, when he found that a horse of that kind could raise a weight of 150 lb. vertically upwards at the rate of 220 ft. per minute, or 2½ miles an hour, by means of a rope passing over a pulley. That is to say, the horse could do work at the rate of $150 \times 220 = 33{,}000$ foot-pounds per minute, and this 'rate of doing work' was accordingly taken by Mr. Watt as the unit in which to express the power of his steam engines and called a *horse-power*. A horse-power, therefore, means the doing of work at the rate of 33,000 foot-pounds per minute, or 550 foot-pounds per second, or 1,980,000 foot-pounds per hour. An average horse, however, working for eight hours a day, can only do work at about two-thirds this rate, or at the rate of 22,000 foot-pounds per minute.

ANIMAL POWER.—The power of animals, working eight hours per day, in comparison with the standard horse-power of 33,000 foot-pounds per minute, is as follows:—

Horse = 22,000 foot-pounds per minute.
Ox = 11,000 to 12,000 foot-pounds per minute.
Mule = 10,000 foot-pounds per minute.
Ass = 3,500 foot-pounds per minute.
Man, turning a crank or pumping water,
= 2,600 to 2,750 foot-pounds per minute.

For short periods only, however, animals may develop much greater powers than the above.

For example: though a man working eight hours a day can only work at the average rate of $\frac{1}{12}$th of a horse-power, for a period of about two minutes only he can work at six times that rate, or develop, during that short interval, half a horse-power.

Animal power may generally be employed with advantage where the work to be done consists of a series of small operations, or where it is not sufficient to keep a larger motor employed regularly. But when the work to be done is large in amount and fairly regular in character, it is usually more economical to employ some other kind of motive power available than animal power.

WIND POWER.—The changes of temperature and humidity which are continually taking place in the atmosphere are accompanied by changes of density, causing the atmosphere in some places to be heavier than in others. According to the laws of gravity, therefore, air currents or wind will be generated by the rush of air from places of greater density to others where the atmosphere is less dense, and the kinetic energy which the air thus possesses in virtue of its motion may be utilized, to some extent, in doing mechanical work. In this respect wind was probably first used as the motive power for propelling sailing ships, but it has also been used from a very early period for driving windmills.

The pressure of wind upon a surface exposed at right angles to the direction of its motion is proportional to the mass of air impinging upon the surface per unit of time and to its velocity. If V be the velocity of the wind in miles per hour, and p the pressure in pounds per square foot of surface, then, according to Smeaton, $p = \frac{V^2}{200}$

Theoretically, the available horse-power of the wind driving, say, a windmill is proportional to the mass of air impinging upon the sails of the wind wheel per unit of time and the square of the wind's velocity. Thus if A be the area of the sails in square feet, and V the velocity of the wind in feet per second, then assuming the volume of air to be 13 cu. ft. per pound, the available horse-power of the wind will be.—

$$= \frac{A \cdot V}{13} \times \frac{V^2}{64 \cdot 4} \div 550 = \frac{A \times V^3}{460,460}.$$

The actual horse-power of the wheel, however, will only be about two-fifths of the theoretical available power of the wind, or as given, roughly, by the following formula.—

$$\text{Actual or effective horse-power} = \frac{A \times V^3}{1,080,000}.$$

As windmills require very little attention, the cost of the power obtained thereby is almost entirely due to interest charges on the capital expended and depreciation.

WATER POWER.—Falling water, under favourable conditions, forms one of the most desirable, as it is one of the most economical, of all sources of power. The utilization of water power often involves the construction of more or less expensive permanent works, such as reservoirs, canals, and dams. Now, where there is a natural waterfall, the water costs nothing; and the costs of upkeep of machinery, &c., and of superintendence are small. The only serious cost of power, therefore, consists of the interest charges on the capital expended in machinery and works, so that if the construction of the latter does not involve much expenditure, the power thus obtained will usually be very much cheaper than steam power, for instance, and will be regular, convenient, and easily controlled.

The power available from a stream of water is directly proportional to the quantity of water passing per unit of time, and to the height of the effective or working fall. To find the horse-power, multiply the quantity of water (Q, say) in cubic feet per minute by the weight of a cubic foot of water (62·4 lb.), and also by the height of the available fall (H, say) in feet; then, dividing the product by 33,000, the result will be the theoretical horse-power. That is to say:

$$\text{Theoretical horse-power} = \frac{Q \times 62 \cdot 4 \times H}{33,000}.$$

The fall, H, must be measured from the level of water in the head race to the level of water in the tail race when the full supply is passing down

The quantity of water, Q, passing per minute can be determined in various ways.

1. By measuring the velocity of the water and the sectional area of the stream. For this purpose, choose a length of the stream, say 50 or 100 ft., along which the section is as uniform as possible, and find the area, A, in square feet, of the section by multiplying the width, in feet, by the average depth, in feet. Then, fixing a stake at each end of the measured length of L feet, say, find the time, t, in seconds, which it takes a float thrown into the middle of the stream to pass from the one stake to the other. The theoretical quantity of water flowing, in cubic feet per minute, will then be:

$$Q' = A \cdot \frac{L}{t} \times 60.$$

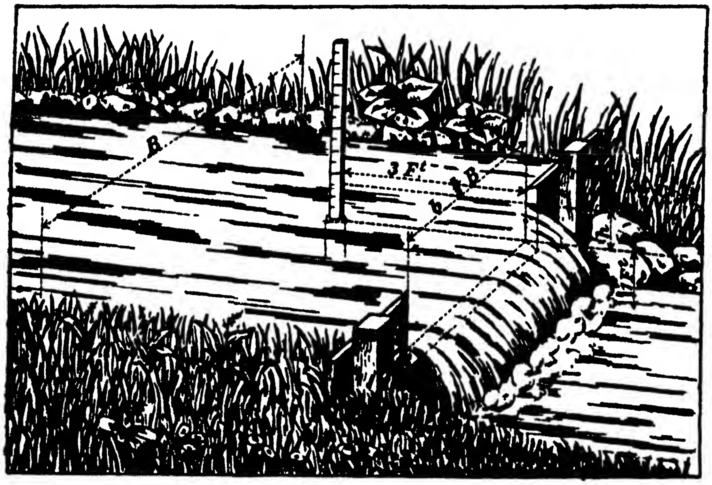
The actual flow, Q, however, will be somewhat less than this, on account of the friction of the sides and bottom of the channel. In the case of a stream with earthen banks, for instance, we shall have Q = ·8 . Q′ to ·85 . Q′.

2. By means of an open-topped notch, as indicated in the figure. Place a board having an open-topped rectangular actch across the stream at a point where the water flows very slowly, the bottom of the notch being set perfectly level and at a sufficient depth to pass all the water to be measured. About 3 ft. or so behind the notch, drive a stake into the bottom of the stream until the top of the stake is level with the notch. When the water has stopped rising over the weir, and is flowing steadily, measure the depth, h, in inches, from the water surface to the top of the stake. Then, if b, the width of the notch in inches, be not less than three times h, the discharge in cubic feet per minute will be given by the formula $Q = 0 \cdot 4025 \times b \times h^{\frac{3}{2}}$.

Water power is utilized and made to perform

useful operations by the aid of machines called hydraulic motors. The energy which the water possesses on entering a motor may be due to its elevation, to its velocity, or (chiefly) to its pressure; or it may be due to any two, or to all three of these circumstances. Further, the water may leave the motor with practically no residual energy, or, from the character of the motor, residual energy in the water on leaving the motor may be unavoidable. Hence motors may be classified according to the character of the energy—potential or kinetic—of the water on entering, and according as to whether residual energy is essential or not in the water leaving the motor after having done work upon it, as in the accompanying Plates.

The effective or actual or brake horse-power of these motors is always less, and often much less, than the theoretical horse-power of the water supplied, and the ratio of the actual to the theoretical horse-power, called the efficiency of the motor, depends upon the type of motor used. For different types of motors the efficiency varies from ·35 to about ·80, as indicated below.



Estimation of Water Power by means of open-topped Notch

Type of Motor.		Efficiency.
Water-wheels.	Undershot wheel	·35
	Poncelet, undershot wheel ...	·60
	Breast wheel	·55
	High breast wheel	·60
	Overshot wheel	·68
Hydraulic ram		·60
Pelton (jet) wheel...		·75
Turbine		·60 to ·80
Water-pressure engine		·80

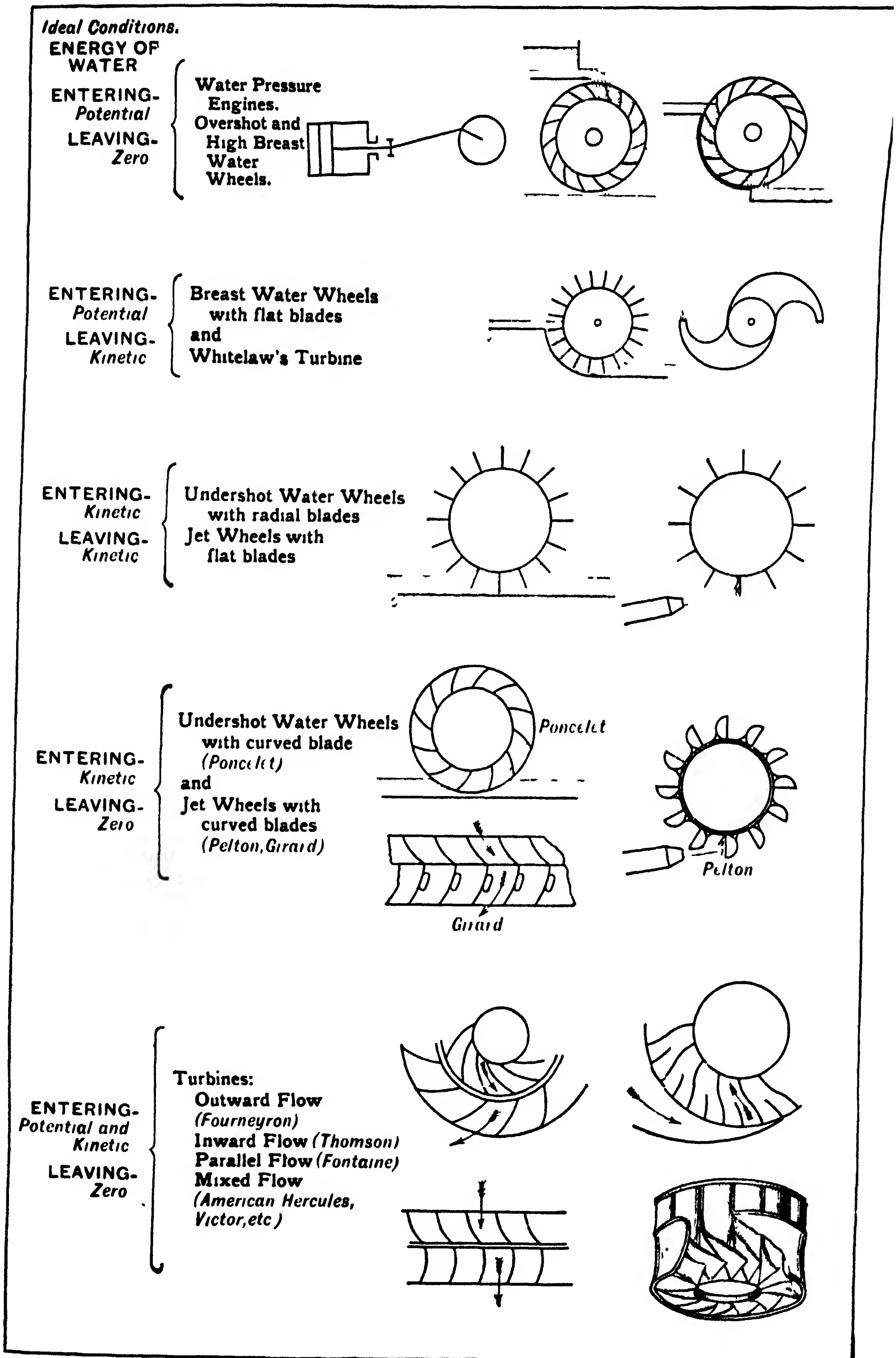
Cost of Water Power.—The cost of water power varies very considerably according to circumstances. In some cases the conditions are so favourable that only constructional work of a very inexpensive character is required, whilst in others the conditions are less favourable and the expenditure required very much greater. In the former cases the water power may be obtained at almost a nominal cost, whilst in the latter it may be excessive, and even greater than that of steam power. According to Mr. Swain, the average cost of the water power in the United States is only £2 per horse-power per annum, or less than half the cost of steam power. He states, however, that it varies very considerably in different localities, the cost in some cases being excessive; as, for instance, in New Jersey, where the cost for interest, depreciation, and water rental amounts to about £12 to £15 per horse-power per annum.

Motive Power Derived from the Combustion of Fuels.—In the final Report of the Royal Commission on Coal Supplies, issued in 1905, the following important statement is made: 'We are convinced that coal is our only reliable source of power, and that there is no real substitute'. This statement was made after the possibility of obtaining power from oil, waterfalls, tides, windmills, and from peat had been fully considered.

It was also estimated by the above Commission that the total coal consumption of the United Kingdom amounted to no less than 167,000,000 tons annually, and of this amount probably 80 millions is utilized entirely for power purposes. Assuming a coal consumption of 5 lb. per brake horse-power per hour—an estimate which is generally acknowledged as reasonable—and an average run of 12 hours per day for 300 days in the year, the annual consumption per horse power would be 8 tons; and as the total annual consumption is 80,000,000 tons, the combined horse-power of all the steam and gas engines in the United Kingdom will probably be about 10,000,000.

The coal consumption per horse-power per hour, however, varies very considerably in different cases. In the case of small non-condensing steam engines, such as are used on the farm, it varies from about 8 to 10 lb.; for engines of the best class, such as are used in factories, it is about 3 lb.; and when the coal is used in gas producers and the gas produced therefrom used in driving gas engines, the coal consumed is often less than 1 lb. per horse-power hour.

The cost of the fuel required per effective or brake horse-power of the engine is, for different cases, approximately as follows: For gas engines using producer gas, $\frac{1}{10}$d. per hour, or £1, 10s. per annum of 3600 working hours; for oil engines of a good type, from $\frac{1}{8}$d. to $\frac{1}{4}$d. per hour, or



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CLASSIFICATION OF HYDRAULIC MOTORS

about £2 to £4 per annum; for gas engines using ordinary town gas, about ¼d. per hour, or £4 per annum.

For small non-condensing steam engines the cost of the coal used is about £8 per horse-power per annum, and for large steam engines of the best class it is usually from £3 to £4. To obtain the net cost of the motive power, however, there remains to be added to the above costs of fuel the cost of stores, interest on capital expenditure, depreciation, and cost of superintendence.

Under the most favourable conditions the total cost of steam power will not be much less than £5 per horse-power per year, but in the case of small powers it may be twice or even three times that amount.

Electricity, as a motive power, is generated by dynamos or alternators driven by water or steam turbines, or by steam, gas, oil, or other engines. The unit of electrical power is the watt, and a standard horse-power of 33,000 foot-pounds per minute is equal to 746 watts.

Electrical power, under the most favourable conditions, and when the power generated is fairly large, can be produced at a cost, so far as the running charges are concerned, of about three-eighths of a penny per electrical horse-power per hour, or at a total cost of less than five-eighths of a penny per electrical horse-power per hour.

The output of an electrical generating plant and the amount of electrical energy supplied to a consumer are, however, usually expressed in Board of Trade units or *Kilowatt hours*.

The Board of Trade unit or Kilowatt hour is equal to the amount of electrical energy which is developed or absorbed by a current of 1000 amperes at a pressure of one volt during one hour. It is therefore equal to 1000 ampere-volt-hours or 1000 watt-hours or $\frac{1000}{746} = 1{\cdot}34$ horse-power-hour.

To utilize electrical power for purposes other than lighting or heating, the current generated by the dynamo is passed through an electrical motor, which transforms the energy of the current into mechanical energy of rotation; that is, into the most convenient form for driving machinery. [H. B.]

Motors, Agricultural.—The agricultural motor, or motor specially adapted for purposes of land cultivation and general use in agriculture, is a comparatively new machine; the first of its class—the 'Ivel' Agricultural Motor—having been introduced within the last eight years, and though introduced so recently, it has already met with such success as to show that it is a practical agricultural machine, and likely to become an important factor in the agriculture of the future. The advantages to be derived from the use of such a motor are: greater speed and economy of working than with horses, and consequently saving of time and money; a considerable reduction of labour and expense as compared with the driving and care of horses, provision of stabling, &c.; and the great variety of purposes for which the motor may be used, for not only can the motor do almost every kind of work usually performed by cattle, but also every kind of work for which ordinary gas, oil, and steam engines are used.

The fuel used in agricultural motors is usually petrol, but other liquid fuels, such as paraffin, kerosene, and alcohol, are utilized as well. The motors have usually two cylinders, each of which is provided with inlet and exhaust valves, a water jacket, a piston, and a connecting rod and a crank, as in ordinary gas and oil engines; and the cycle of operations—called the four-stroke or Otto cycle—is as follows. During the first—outward—stroke of the cycle a mixture of petrol or oil vapour and air is drawn from a carburettor, through an inlet valve, into the cylinder, where it is compressed during the second—inward—stroke. At the beginning of the third stroke the mixture of vapour and air is ignited by an electric spark or by some other means, and the pressure caused by the expansion or explosion which follows drives the piston outwards with great force, thus performing the third or working stroke and furnishing energy enough for the three strokes in which there is no impulse. This energy is stored in the flywheel on the crank shaft during the working stroke and restored during the next three strokes of the cycle. On the return of the piston, during the fourth and last stroke of the cycle, the inert products of combustion are driven out through the exhaust valve and the cycle completed.

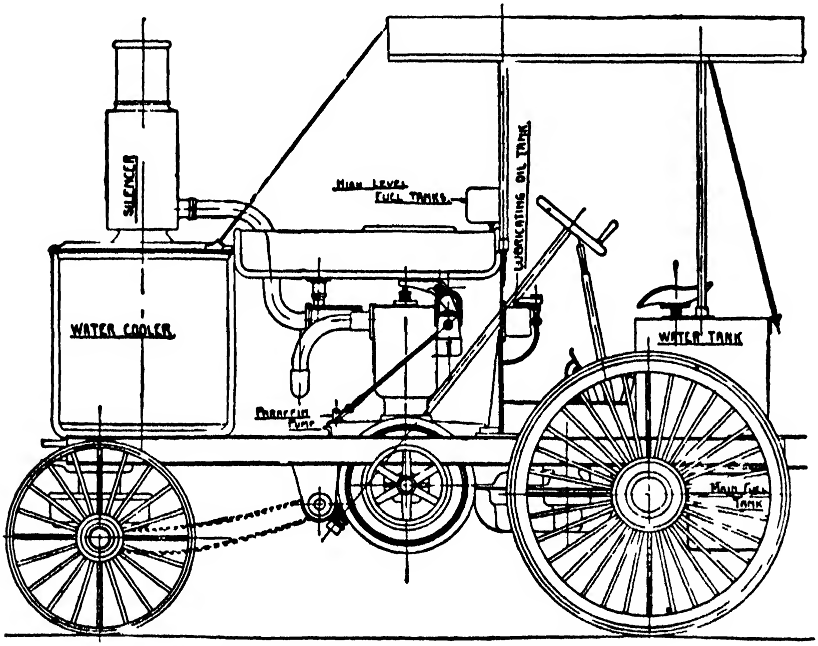
For stationary work, such as driving a threshing machine, chaff cutter, dynamo, grinding mill, or a pump, a driving pulley is fitted on to the end of the crank shaft and suitably placed for driving the machine by means of a belt. For ploughing, mowing, reaping, cultivating, &c., the motor is used as a 'tractor', hauling the implement or implements in the rear, and the motion of the crank shaft is communicated to the driving wheels by means of friction clutches and chain and spur gearing as described in detail below.

Of the various motors constructed the three selected for illustration are the 'Ivel' Agricultural Motor, the 'Marshall' Agricultural Oil Motor, and the General Agricultural Tractor constructed by the Cyclone Agricultural Tractor Co. Ltd., London. The Ivel motor, shown at work in the first figure on the plate, hauling two reapers and binders, is driven by a two-cylinder horizontal engine which is stated to develop 20 brake-horse-power at a speed of 850 revolutions per minute of the crank shaft when using petrol as fuel.

The total weight of the motor is only 32 cwt., and being supported on three broad wheels it can run on most roads, and makes but little impression on the land. The fuel generally used for driving the motor is petrol, but paraffin or alcohol may be used instead, and when working at its full capacity it consumes about 2½ gal. per hour. The capacity of the machine and cost at which various kinds of work can be performed by it, are indicated by the recorded results of the following trials: (1) When hauling a three-furrow plough the tractor is recorded as having ploughed 6 ac. 1 rood 9 poles of hard-surfaced land to a

depth of 7 in. in 8 hours 54 minutes; the cost working out at the rate of 5*s.* per acre, including petrol, lubricating oil, and men's time. (2) Drawing a reaping and mowing machine, 19 ac. of wheat were cut in 10 hours, at a cost of 1*s.* 9*d.* per acre. (3) Driving a chaff cutter, 1 ton 1½ cwt. of chaff was cut to a gauge of ⅜ in. long in 47 minutes, at a total cost of 2*s.* 6*d.*

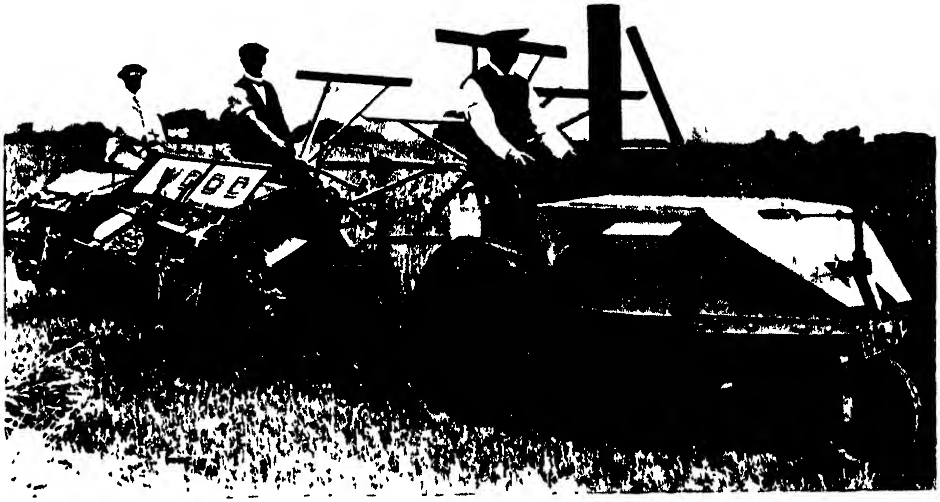
The 'Marshall' Agricultural Oil Motor, constructed by Messrs. Marshall, Sons & Co., Ltd., Gainsborough, is shown at work, in the second figure of the plate, hauling two four-furrow ploughs in light land. It is much heavier and more powerful than the Ivel motor, weighing, in complete working order, including the weight of the driver and cooling water, about 4½ tons, and developing, when working at its full capacity, as much as 30 actual or brake horse-power. The engine, which has two cylinders cast in one piece with a water jacket, is supported on a channel steel frame, the water cooler being carried at the front end, and an extra water tank at the back end. The whole weight of the machine is carried upon four broad wheels, two in front and two in the rear, the hind wheels, which are the driving wheels, being much larger and broader than the front wheels, and more heavily loaded. All levers and handles for manipulating the motor are conveniently placed for easy access by the driver, as is evident from the diagram, which



Diagrammatic Section of the 'Marshall' Agricultural Oil Motor

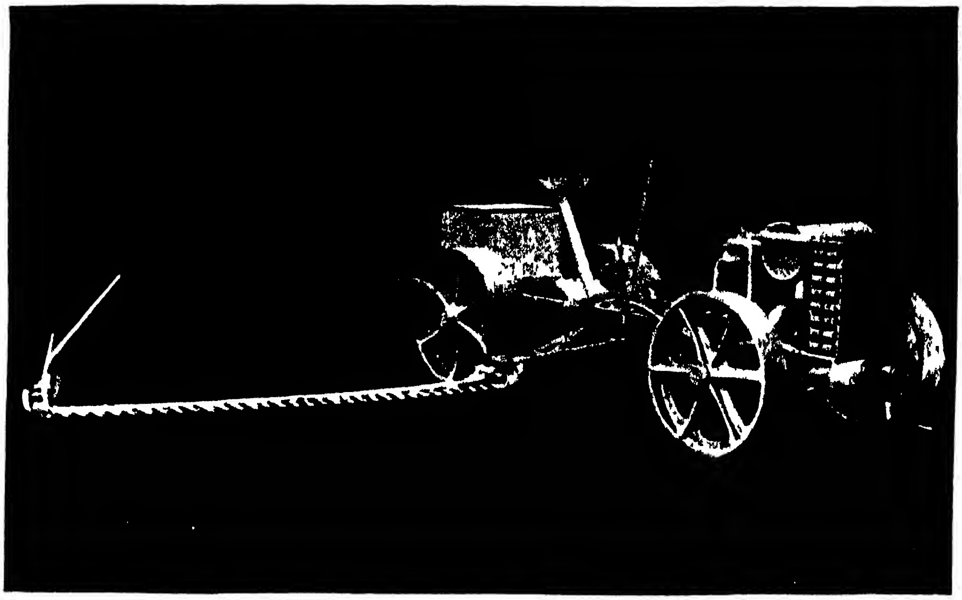
shows also the general arrangement of the motor. The fuel chiefly used for driving the engine is paraffin, but benzene, kerosene, petrol, or alcohol may be used if desired. When paraffin is used the engine is first started with petrol, and after running for a few minutes the petrol cock is closed and the paraffin cock is opened. The paraffin in the supply tank is maintained at a constant level by means of a small pump worked by an eccentric from the cam shaft. On the crank shaft a driving pulley is fitted and suitably placed for driving, by means of a belt, such machines as pumps, dynamos, threshing machines, chaff cutters, &c., and as a 'tractor' the motor can be used for ploughing, cultivating, mowing, hauling loads along common roads, &c. The motor can thus be kept in use all the year round doing work upon or about the farm, and in order to render it suitable for such a variety of purposes it is fitted with three speeds for 2, 4, and 6 miles per hour, with reverse on the slowest speed. In a twenty-four hours continuous ploughing test carried out with this motor in a 36-ac. field near Gainsborough—the motor hauling a four-furrow plough and a two-furrow plough—21½ ac. of heavy land were ploughed to a depth of 5 or 6 in. at a total cost of 3*s.* 1*d.* per acre. This cost, which includes fuel, stores, labour charges, interest on capital at 5 per cent, and depreciation at 20 per cent per annum, is only about a fourth of what it would have been had the same work been done by horses.

The General Agricultural Tractor shown in Plate was exhibited as a 'new implement' at the Gloucester show of the Royal Agricultural Society in June, 1909, and for it the makers—The Cyclone Agricultural Tractor Co. Ltd., London—were awarded a silver medal. Its special feature is an arrangement for driving a mowing knife direct off the engine shaft by means of an eccentric. It can, however, be also used for hauling a two-furrow plough or any

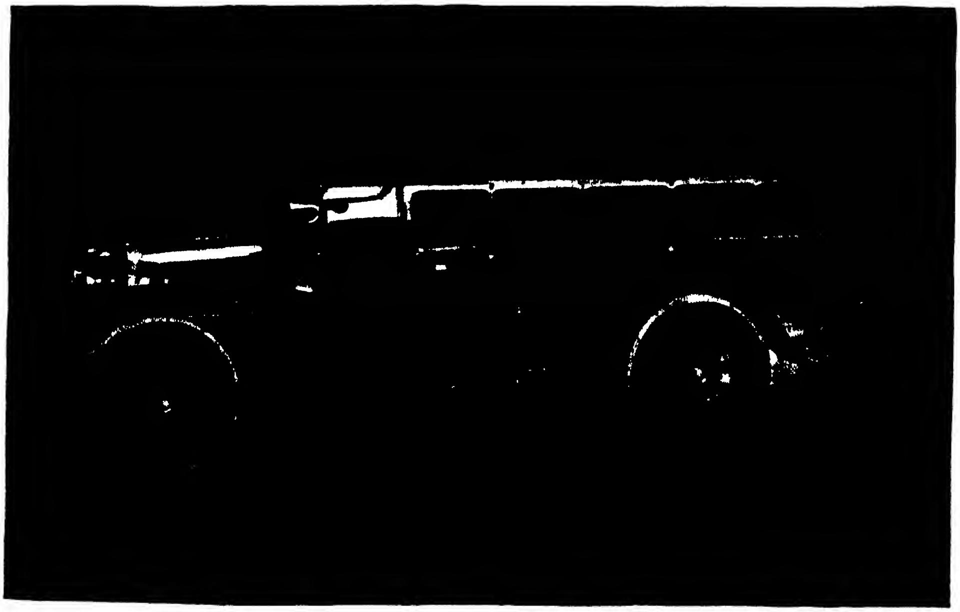


IVEL AGRICULTURAL MOTOR
HAULING TWO SELF-BINDING REAPERS

MARSHALL'S AGRICULTURAL MOTOR
DRAWING TWO FOUR-FURROW PLOUGHS



GENERAL AGRICULTURAL TRACTOR
(Cyclone Agricultural Tractor Co., Ltd., Moorgate Street, London)



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16 H.P. COMMERCIAL MOTOR VEHICLE
(Albion Motor Car Co., Scotstoun)

other agricultural implement. The tractor is fitted with an Aster engine of 20 brake-horse-power, and is provided with a belt pulley for driving dynamos, pumps, threshing machines, and the like.

Under favourable conditions agricultural motors are undoubtedly more economical than horses; they are also capable of performing many agricultural operations far more expeditiously than is possible with horses—an advantage often of the greatest importance. [H. B.]

Motor Vehicles.—Motor vehicles, or self-propelled vehicles for use on common roads, have many advantages over horses as used for traction purposes, for in addition to the inherent advantages which mechanical traction in general possesses over horse haulage, they possess the further advantages of greater speed, greater power, and of greater economy. Further, the motor, as now manufactured, is a reliable, a smooth-working, and a very efficient machine; hence there is small wonder at its having come so rapidly into popular favour as it has done during the past few years, or of its being so extensively used in preference to horses, as it now is, not only for pleasure or touring purposes, but for a great variety of commercial purposes as well.

In these motors electricity, compressed air, steam, petrol or petroleum spirit, and alcohol have each been used more or less successfully. Electricity and compressed air, however, are quite unsuitable for general use, as energy in these forms can only be stored, on the vehicles themselves, in comparatively small quantities, which, sufficing for a run of a few miles only, requires to be renewed at frequent intervals. Alcohol as a fuel for internal-combustion motors is being used to a certain extent on the Continent, but in this country it cannot be used economically, at present, on account of its cost, which is prohibitive. We have thus left only steam and petrol that are suitable for general use in motor vehicles, and of these two petrol, so far, has proved to be the more successful and the more economical for vehicles having solid rubber or pneumatic tyres. For heavy vehicles having steel tyres, steam-driven motors are more suitable than petrol motors, as the latter are more liable to injury than the former from the excessive vibrations to which such vehicles are subject.

A commercial motor vehicle, such as that shown in Plate, carrying 25 cwt. exclusive of its own weight and that of two persons, and running on rubber tyres, is quite capable of a 60-mile daily run, if but few stops are necessary. Of course the actual performance will depend largely upon the number of stops required to be made, and the whole secret of successfully running such vehicles is to so organize the runs that the stops shall be as few and as far apart as possible. A little forethought in mapping out the runs of a motor van will often reduce the running costs considerably. Under moderately favourable conditions a daily run of 50 miles, for 300 days a year, may be reasonably expected; and a motor van doing this and having a capacity of 25 cwt. net, will be equivalent to from four to six horses and two vans. Under suitable conditions the advantages of motor traction over horse haulage is shown, so far as gross annual costs are concerned, by the following comparative figures:—

RUNNING COSTS OF A 25-CWT. ALBION VAN

Standing Charges

	£	s.	d.
Interest on capital at 5 per cent ...	22	0	0
Depreciation at 15 per cent ...	67	0	0
Driver's wages, 52 weeks at 30s. ...	78	0	0
Insurance	10	0	0
Garage	12	0	0
	189	0	0

Running Charges in Pence per Mile

	d.
Tyres at 10,000 miles per set (low estimate) . . .	1·5
Petrol	1·1
Lubricating oil, grease, &c	·05
Repairs and renewals ...	·50
	3·15

	Per annum. £	s.	d.
Assuming a run of 50 miles per day, for 300 days a year, running charges = 50 × 300 × 3 15*d*, or	197	0	0
Add standing charges	189	0	0
Gross annual cost .	386	0	0

HORSE TRACTION

One 25-cwt motor van equal to four horses and two vans (low estimate)

	£	s.	d.
Initial cost of two vans at £45 each	90	0	0
Four horses at £40 .	160	0	0
Two sets harness at £10 .	20	0	0
Sundries .	5	0	0
	275	0	0
Interest on capital at 5 per cent	13	15	0
Depreciation on £250 (four horses and two vans) at 15 per cent	37	10	0
Two drivers at 28s per week	146	0	0
Forage, four horses at 10s. 6d. per week	109	0	0
Shoeing and vet, four horses at £8 per annum	32	0	0
Stabling four horses and two vans at 24s	62	0	0
Insurance	8	0	0
One ostler at 25s per week .	65	0	0
Renewals two vans, sundries, &c .	8	0	0
	481	5	0

[H. B.]

Mouflon, or **Musmon** (*Ovis musimon*), the only species of wild sheep known to occur in Europe. This sheep is alleged to have existed formerly in Spain, the Balearic Islands, and other countries of South Europe, but it is at the present time restricted to the islands of Sardinia and Corsica, and it is doubtful if the records of its occurrence elsewhere are to be trusted. Even in Corsica it appears to be very scarce and verging on extinction if not wholly extinct; and in Sardinia it is far less plentiful than formerly. As in all wild sheep the coat is hairy, with underwool in the winter. In typical examples the colour is dark-reddish or brownish-black mixed with grey, with a darker

spinal streak; and there is a conspicuous grey 'saddle mark' on each side of the body. The face is greyish; the muzzle, belly, and inside of the limbs are white or whitish, and a black stripe extends down the front and outer side of the fore legs, and a similar but less well-defined mark on the hind legs, which contrasts strongly with the white on the inner side of these legs below the knees and hocks. The tail is only a few inches long. The ewes are hornless or carry small horns. In the rams the horns are large and spread wide of the head on each side, forming a curve of about two-thirds of a circle, but without any spiral twist. 30 in. is about their average length, the record length being 38½ in. In the rams also there is a distinct mane on the throat and also on the nape of the neck. Like all wild sheep, Mouflon are extremely wary and difficult to shoot, since they frequent the highest ridges of mountain ranges commanding a wide view of the surrounding country. They live in herds usually headed by an old ram; but in the breeding season in the winter the herds break up into smaller parties consisting of one ram and several ewes. Lambs are born in the late spring.

The term Mouflon is sometimes loosely applied to several distinct species of sheep, and has even been used for the Aoudad, Arui or Bearded Argali (*Ammotragus lervia*), which in the strict sense of the word is not a sheep at all. It has also been given to the wild sheep of Cyprus, the Cyprian Mouflon (*Ovis ophion*), which appears to be nothing but an isolated local race of the Armenian and Persian species, *Ovis orientalis* or *gmelini*. This animal differs from the true Mouflon principally in having the horns curving backwards over the neck and in being of a much paler and more sandy hue.

It has been claimed that of all wild sheep the Sardinian Mouflon is most nearly allied to domestic races, with which it readily crosses; and it has been supposed that it may be the ancestral stock, or one of the ancestral stocks, whence domestic sheep are descended. Apart, however, from the shortness of the tail, the Mouflon differs from all domestic sheep in certain skull characters, the forehead being more elevated, the orbits more prominent, and the horns arising more forwards over the eyes. In view of these differences, the opinion above stated cannot be accepted as well established.

[R. I. P.]

Moulds. See FUNGI.

Moulds or Fungi in Cheese.—There is a somewhat extensive variety of cheeses, both firm and soft in character, which, although not pressed like the Cheddar and cheese of a similar type, owe their popularity, their texture, and their flavour to the mould which grows upon the surface or within. The leading veined or moulded cheeses, which are described in French as *persillé*, are in England, Stilton and Wensleydale; while in France they are the Roquefort, the Gex, the Mont Cenis, the Sassenage, and the Septmoncel, Italy claiming the Gorgonzola. Among the chief varieties of soft cheese on which the fungus grows upon the crust are the Brie, the Coulommiers, the Camembert, the Pont l'Évêque, the Mont d'Or, and the Bondon. The fungi or moulds which play an important part in these various products are the blue—*Penicillium glaucum*; a mould of a similar character, which Lezé declares to be closely allied to this fungus, but not the actual *P. glaucum* as we know it in relation to the firmer cheeses—*Oïdium lactis*, which plays a leading part in the production of the Camembert; and *P. candidum*, which is now recognized by the name which it has received from the American expert Thom—*P. Camemberti*.

It is to the last two varieties to which we specially refer. *P. Camemberti* is the indispensable and dominating mould which grows upon the crust of the Camembert cheese like a white velvet pile, and which appears in the drying room in the first stage of the ripening process. The cheese gradually acquires, as the cheeses are turned from day to day, a grey or bluish tint, owing to a large extent to a growth of the blue mould to which reference has been made. It has been ascertained by repeated experiment that the white mould found on all good cheese is identical. Pure cultures are easily prepared, and there are cases in which preparation is essential, especially in new dairies, which are not impregnated as are others with the spores of this useful fungus. The cultivation of *P. candidum* may also be essential if the conidia lose, as they may do, their power of germination where the fungus becomes too dry. Development, however, is rapid upon moist curd, within which its mycelium penetrates removing the acid and leaving the curd in an alkaline condition. Its work is then completed, inasmuch as it has prepared the way for bacterial activity and the consequent ripening of the curd, which becomes soluble and piquant on the palate.

The same variety of fungus described under another name—*P. album*—performs similar work during the process of the manufacture of Brie. It attacks the lactic acid in the curd in a similar way, leaving the bacteria to complete the work. According to Duclaux, it is unwise of the maker to allow this mould to develop too much, as an opportunity is given for the too free development of the blue, or the fatal black, variety. It may be checked by the more frequent turning of the cheese, when the mould is damaged or destroyed, or by reducing the temperature of the ripening apartment.

Oïdium lactis also plays a part of great importance in the manufacture of Brie, and possibly in other kinds of cheese apart from Camembert. Its spores are present in the air in abundance wherever soft cheese is made, while the walls, benches, and utensils are frequently covered with the mould. *O. lactis* is an active agent in fermentation, and is present in all good Camemberts; its peculiar property is to influence the bouquet of the cheese. In an experiment by Thom, in which two sets of cheeses were made, those from which *O. lactis* was excluded possessed no bouquet at all, although otherwise good, whereas those in which it was present possessed a perfect bouquet. *O. lactis*, however, should not be present in excess, for it is known to be an occasional cause of failure,

producing an oiliness in the cheese with a resulting imperfect flavour.

'This fungus is easily distinguished from *P. Camemberti* by examination through a magnifying glass, or, better still, a microscope. We do not find', Lezé tells us, 'the graceful and delicate crests or the pencils which support the conidia, but we are able to distinguish the shoots of the jointed mycelium. These are in turn divided into small rectangles, in each of which is an oïdium. The mycelium may be described as a basis, grafted on to which are wreaths of oïdia, somewhat similar to saccharomyces, but distinguished by their rectilinear form; they are, in fact, rectangular with the corners rounded off.' [J. Lo.]

Moulting. — The process of casting the feathers goes on throughout the entire year, as poultry-keepers know, but during the later summer or autumn it is customary for the whole of the plumage to be renewed. This creates a demand upon the system for the material necessary to formation of the feathers, and unless care is taken, the constitution of the bird may suffer therefrom. Some breeds pass more easily through the moult than do others, and it is an interesting fact that every year the period of moulting becomes more prolonged and difficult. It is very seldom that a hen lays during the moulting time—in fact it is undesirable that she should do so, because otherwise there will be too great a strain upon her system. Those whose object is egg production should always seek to get their birds through the moult as early as possible, so that they may recommence laying before the winter arrives. As soon, therefore, as it is seen that the feathers are beginning to be cast, food should be given which will supply the material for the formation of the new coat. It is an excellent plan to put a little sulphate of iron and sulphuric acid in the drinking water, as that appears to have the effect of loosening the feathers; and to give meat in one form or another as part of the food. Where natural food is abundant there is no need for such meat to be supplied artificially. [E. B.]

Mountain Ash, the name sometimes applied to the Rowan. See SERVICE TREE.

Mountain Breeds of Sheep. — These are easier to define than lowland sheep, because, while mountain sheep may be imported for fattening purposes on to more fertile tracts, it would be hazardous to attempt the reverse process with lowland sheep. The mountain sheep may be converted into a lowlander, but the lowlander cannot so easily be converted into a highlander. The conditions are harsher, the soil poorer, the herbage scantier, and the climatic conditions more turbulent. We have in Great Britain and Ireland many kinds of true mountain sheep, characterized by their small size, light weight, active habits, parti-coloured wool, and speckled faces. They are also mostly provided with horns, and in some cases possess the instincts of the goat and of the chamois, rather than the passivity of the pampered heavy breeds (see LONG-WOOLLED SHEEP and LOWLAND BREEDS OF SHEEP). Such are the original Zetland breed, famous for the fine wool used in the manufacture of Shetland shawls. They are small and nimble, and inured to much hardship. Next in order come the Scottish Blackfaced or heath sheep, accredited with eating heather which communicates a flavour to the flesh, similar to venison or even to grouse. These sheep are also claimed to be of English origin, and extend from the moors of Dumfries, over the border, into the waste lands of the English northern counties; through Yorkshire, down to the Peak district of Derbyshire. They also are largely kept on the mountains of Wales, and have recently been imported on to the chalk downs of Wiltshire. This is a true Highland breed, inhabiting the black heathery mountains, and possessed of all the unruly instincts of the mountaineer. Cheviot boasts another, but very distinct, breed of great hardihood, and tended by the most faithful race of shepherds in the world. Across the Border, southward, are found the Herdwicks of Westmorland, the Lonks and the Limestone Crag sheep of Lancashire, the Clun and Morfe common sheep, the Welsh mountain sheep, the native Exmoor and Dartmoor sheep, and, as a horned and native breed, although scarcely a mountain breed, the Dorset. Of these most are horned, although in some breeds these appendages are confined to the rams. In some cases the horns have disappeared under the influences of selection, but all the breeds above named bear the impress of original races. It must not, however, be thought that they have remained unimproved, for the contrary is the case. The Scotch Blackfaced sheep have been developed under the stimulus of showyard competition; and no breed has escaped the influences of careful selection and cultivation. Some of the mountain breeds, as for instance those of the Wicklow Mountains in Ireland, are particoloured and of wild appearance. The number of distinct breeds is a remarkable feature; but space forbids more than mentioning such breeds as the Radnor, and the Kerry Hill sheep of Montgomery. Many of them only scale from 7 to 12 lb. per quarter, and all of them produce mutton of exceptionally good quality. This is only a general note as to what is meant by 'mountain sheep', and readers are referred to the special articles on each breed for fuller particulars. [J. Wr.]

Mouse, a general name for several species of the rodent genus Mus, which also includes the rats. The genus is distinguished from the allied genus Microtus or Arvicola, to which the 'field mice' or voles belong, by the possession of rooted molar teeth, surmounted by tubercles, and by the long and scaly tail. The Common Mouse (*Mus musculus*) is about 3½ in. in length; the tail measures 3¼ in. Its distribution is nearly world-wide, and it is always found in association with man. Its original home is not known. Though it has many enemies, it holds its own by reason of its extraordinary fecundity The female is mature at a few months old, and brings forth several litters of four or five young in a year. The Common Mouse is not confined to houses alone, but frequents barns, outhouses, and especially the space beneath cornstacks in

enormous numbers. It is best kept down by keeping numbers of semi-wild cats about the farmsteading, and tame cats in the house. Traps baited with cheese or meal are also effective.

The Wood Mouse (*M. sylvaticus*) is slightly larger than the Common Mouse. It is reddish-brown above, white on the under parts, with very long, white hind feet. It frequents thickets, fields, and gardens, and, as it is almost entirely a vegetable feeder, it does great damage. It does not hibernate throughout the winter, but makes a burrow, near which it buries large stores of grain, peas, beans, seeds, and the like, for use in cold weather, 'so that the unfortunate farmer or gardener has to support the creature from one end of the year to the other'. The rate of increase of this species is even more rapid than that of the Common Mouse. Two females kept in captivity by a naturalist, began to breed at five and a half months old, and brought forth between them 36 young ones between 7th March and 9th July! It is suggested that the number of young ones in each litter (3 to 5) would have been larger in a wild state. The longest interval between two litters was twenty-nine days. Luckily the Wood Mouse is preyed upon by many birds, including the Black-headed Gulls, and it is a favourite dainty with weasels, stoats, and foxes.

The Harvest Mouse (*M. minutus*) measures only 2½ in. in length. It is the smallest of British mammals except the Lesser Shrew, which measures only 2 in. In general colouring it resembles the Wood Mouse. It is found throughout Great Britain from Aberdeenshire southwards, but is not certainly known to occur in Ireland. It makes a remarkable nest for its young by cutting leaves into long narrow strips and weaving them into a hollow ball, which it lines with soft vegetable substances. The nest is usually suspended between two cornstalks several inches from the ground. The full-grown mouse is so light that it can run up a stalk to get at the grain. This mouse also stores for winter use, but is more torpid, and requires a much smaller quantity than the Wood Mouse.

The white mice, so well known as pets, are an albino variety of the Common Mouse, of which colour variations are frequent. See Rat, Vole, Mice, Damage to Woodlands. [J. A. T.]

Mouth, Diseases of and Injuries to. — The mouths of animals at all ages are liable to accident and disease, and the horse is exposed to additional risks by the use of the bit. The angles of the mouth (see Lips, Injuries to) are first inflamed and then hardened by bits that injure by their severity, or by the foolish application of blisters to make the horse for the moment more tractable. The gums and lining membrane of the mouth generally participate when eruptions such as stomatitis, or foot-and-mouth disease, affect the lips. From lodgment of particles of food between the teeth the gums are inflamed, and the jawbone itself may be affected. The teeth of animals are not very prone to decay, but diseased alveolar processes and fangs are not rare as the result of continued irritation in the interdental spaces, or the loss of one tooth leading to excessive growth of its fellow on the opposite jaw. The swelling of the gum and bars of the palate behind the top row of incisors is spoken of as lampas (see Lampas). The roof of the mouth and the sides, the floor (usually covered by the tongue), and the back part or fauces are all liable to injury by thorns, nails, glass, splinters of wood and stone, pieces of fencing, wire, and tin pots, which seem to have a special affinity for foodstuffs; so much so, that certain large forage cutters have magnetic appliances for withdrawing bits of iron in the course of chaff cutting and sifting. The soft palate is sometimes injured by giving balls on a pointed stick, and abscesses occasionally form at the back of the pharynx. Splinters of bone come through the gums between the molars and the incisors, as a result of previous injury by the bit (see Breaking). The tongue is not often injured upon its dorsal surface, as the covering membrane is extremely dense, and the sense of taste is due to the papillæ, especially those on the back part. The sides are the more frequent seat of embedded thorns and splinters, for here the mobility of the tongue is least effective in removing objects. The tongue in the horse and the dog is broader, longer, and relatively thinner than the tongue of ruminants, and not so much protected by the dense membrane, hence more often injured; but cattle are more prone to wooden tongue (see Actinomycosis) and tubercular lesions, and deposits in the glands connected with the mouth and pouring their secretions into it.

Serious injuries and loss of a portion of the tongue have frequently resulted from the barbarous custom of applying the twitch to horses. Horses, pigs, dogs, and cats sometimes bite the tongue and fail to release it from the tush or canine tooth upon which it is impaled. Great swelling and much inflammation results, and a foul odour, as in all cases where the mouth membranes are exposed to the air for any length of time. An anthracoid disease of the tongue, which becomes too big for the mouth, has been described under Anthrax, and on reference to Rabies the reader will find a like condition alluded to in dogs. *Treatment* of injuries and diseases of the mouth offers good prospects of success, so long as the animal can keep the oral cavity closed and benefit by the warmth and moisture. Removal of foreign bodies and the application of boracic acid and glycerine, alum or tannic acid, is nearly always followed by repair in a short time. Cleansing of the interdental spaces with a solution of permanganate of potash is recommended. In order to effect repairs within the mouth, nature demands no more than the removal of the cause, be it local or constitutional. [H. L.]

Mowers. See Haymaking Machinery and Reaping Machines.

Mowing.—Mowing with a scythe is a far less important art than it was before the introduction of the mowing machine; still there are occasions when the machine cannot be profitably employed, then the scythe is needed. Mowing always involves hard work on the scytheman, but a skilled man may mow two acres a day of a well-standing crop, such as clover, without being

unduly taxed, while another man equally strong may be knocked up with mowing an acre. The former mows with a body swing, and the latter mainly with his arms. A good mower lays in the point of his scythe at the height he will mow right through the stroke, and he points out his stroke so that it leaves a perfectly level stubble. The back of the scythe blade acts as a runner, and if towards the end of the stroke the left hand is brought sharply round the left knee, there is no likelihood of the point striking into the ground, and the mower has great power to finish his stroke at the time when the heaviest load is on the scythe. Scythes can be set to take a higher or lower cut or a wider or narrower one by altering the angle made by the blade to the handle or 'sned'. When mowing corn it is customary to fix on a bow or cradle at the end of the 'sned', so that the corn as cut may be swept forward and fall straight in the swath. These cradles are very simple, and take somewhat different forms in different localities. An essential part of mowing is efficient whetting or sharpening, and the whetstone or hone should be applied flat to the blade, or a short bevel will be formed which will soon lose its edge. [W. J. M.]

Mud.—The mud collected from the bottom of ponds, ditches, &c., possesses a certain manurial value, but not as much as might be expected. The fermentation processes going on in stagnant water are fairly complete, and they result in the decomposition of organic matter with formation of marsh gas, carbonic acid, hydrogen, ammonia, and other substances. The marsh gas, being insoluble, is steadily given off, and forms the bubbles which continuously rise to the surface of stagnant water. It is obtained in larger quantities when the mud is stirred up so that the gas mechanically entangled can be liberated; in these circumstances it may be collected in a bottle filled with water, or the larger bubbles can be ignited on the surface of the water. The ammonia and other nitrogen compounds dissolve in the water; indeed their presence is a sure indication that decomposition of organic matter is going on.

Analyses made by the writer of two samples of mud are given below. *A* was from a stagnant pond which had not been cleaned for seventy years, and which was regularly a mass of weeds, such as silk weed, *Nymphæa alba*, &c., throughout the summer. *B* was from a pond into which a little ditch and some drains discharged, and was also well stocked with weeds. Yet neither sample of mud is rich, or worth much as fertilizer.

	Water.	Organic matter.	Nitrogen.
A	23·3	7·8	·183
B	52·2	7·3	·175

Some muds contain a certain amount of calcium carbonate in consequence of the presence of shells; where these have accumulated through great periods of time they form marls of considerable value. But so long as they are simply mud they are not worth any great expenditure in carting and spreading, unless analysis shows the presence of sufficient nitrogen or calcium carbonate.

The sticky, greasy mud of a hard road or a town owes its stickiness to the deflocculated clay. The calcium carbonate and soluble salts having been washed out, the clay floccules break down (see art. CLAY), and in this state reveal their extreme tenacity. [E. J. R.]

Mud Fever, an inflamed condition of the skin of those parts of the horse most spattered in wet weather, as the back of the front legs, the front of the hind ones, the thighs, belly, and chest. Hunters are the chief victims, but there are seasons when horses used only on the road suffer badly, and some contagium has been suggested, but not discovered, as the cause. Washing with warm water provokes it. Allowing the mud to dry on horses whose legs have not been clipped, confers a large degree of immunity. Considerable inflammation, swelling of the legs, symptoms of fever and stiffness characterize the disease. The skin subsequently desquamates, much hair is lost, and the animal disfigured until the new coat comes again. Soothing applications of glycerinated water—5 to 10 per cent applied warm; and when dry again, a liniment of 1 part Goulard's extract to 8 parts of linseed or olive oil, have been found to give most comfort, and permit the painful skin to stretch and accommodate the swelling within. A few cooling saline doses, as 1 oz. of bicarbonate of potash, and 1 or 2 oz. of sulphate of magnesium, or ½ oz. of nitrate of potash daily, facilitate recovery. [H. L.]

Muirburn. See HEATHER BURNING.

Muir Ill, a synonym for Red Water.

Mulberry.—This agreeable sub-acid fruit would be of more importance commercially were it not for the fact that it deteriorates very rapidly; indeed, to be really enjoyed it should be partaken of quite fresh from the tree. Old trees bear the best, and many fine specimens are thought to date from the reign of James I, when mulberries were extensively planted to aid in the production of silk, an industry which it was then hoped to establish in this country. It is not, however, the leaves of the fruit-bearing Mulberry (*Morus nigra*, nat. ord. Urticaceæ, a native of Persia) which are most relished by silkworms, but those of *M. alba*, the White Mulberry. *M. rubra*, a North American species, produces dark-red berries, but they are greatly inferior to those of the Black. The Mulberry is best suited by a rich deep, rather light loam, which should be neither particularly dry nor wet. A southern position is to be preferred (in the far north, wall cultivation is required); and as the berries ripen very irregularly, and many fall before they are ripe, in order to save them from being spoilt it is best to plant mulberries upon a lawn. Propagation is by layering the young branches in autumn or spring, but advantage might well be taken of the fact that quite large fruit-bearing branches will readily root if inserted in autumn to the depth of a foot or so in good soil. The Mulberry requires but little pruning, but it is of importance that young plants should be regularly transplanted, and trained with straight stems and good heads. When planted in their permanent

positions care should be taken that the soil conditions are as good as can be secured for the future welfare of such a long-lived and fruitful tree. [W. W.]

Mulches.—The importance of moisture to farm crops is not often realized to the full by farmers in the northern part of Great Britain, largely because the crops do not usually suffer very much from lack of water, except on sandy and gravelly soils or in dry seasons. In the south of England, in America, and on the Continent, the preservation of soil moisture is of prime importance, and great care has to be exercised in this direction if the growing of farm crops is to be a success. There is no doubt that in Great Britain sufficient rain falls in the year for the requirements of crops, if it were only distributed over the year instead of coming mostly in the wintertime, when the land is either bare or the crops are more or less in a dormant state.

The problem is, how can we conserve the excessive amount of rain which falls in the winter. One of the ways in which it can be done is by the application of mulches. A mulch is anything laid on the soil in such a way as to hinder the evaporation of water from the surface. For this purpose, straw, leaves, stones, and a thin layer of dry soil are all more or less effective.

Straw is chiefly used in gardens. Leaves provide a natural mulch in woodlands by falling in the wintertime on the surface of the soil above the roots. The importance of stones as conservers of moisture was well known by Lord Bacon, when he said that a heap of stones round a young tree brought it on twice as fast as one without the stones on the surface, his explanation being that the stones conserved the moisture. In the south-east of England there are dry valleys almost covered with flints on the surface. In the wintertime there is plenty of moisture, and these flints conserve the moisture in the summertime. It has been reported that a new tenant carted these flints off the land, with the result that his crop turned out a failure. After discovering his error, he carted them back again.

Soil mulches, however, are by far the most important to the agriculturist. In the spring and summer the moisture from the subsoil is drawn up to the surface, just as oil is drawn up by the 'wick' of a paraffin lamp. After reaching the surface the moisture is evaporated and escapes into the atmosphere. This evaporation is most rapid with a hot sun and a strong wind. By stirring the surface soil to the depth of a few inches, after it has become sufficiently dry, the connection is broken between the upper layer and the soil below, with the result that the escape of moisture from the soil is considerably diminished.

In American experiments reported on by Professor King, the following results were obtained on a sandy loam:—

Table showing Water Lost in 100 Days, stated as inches of Rainfall

No mulch	6·55 inches.
Mulch 1 in. deep	3·30 ,,
Mulch 2 ,, ...	2·99 ,,
Mulch 3 ,, ...	2·54 ,,
Mulch 4 ,, ...	2·78 ,,

The point must not be overlooked that the experiment was carried out in a country where the evaporation of water from the soil is very great. In Great Britain the same principle holds good, but the amount of water lost per year is much smaller. In the above table the mulching has reduced the loss of water to one-half, and the 3-in. mulch has been the most effective. This is rather convenient, as 3 in. is about the depth an ordinary harrow would go by being dragged over the surface.

The effectiveness of a soil mulch, however, varies with different kinds of soil. These figures are also taken from American experiments reported on by Professor King:—

Table showing Water Lost on Different Soils —Mulch 2 in. deep

Coarse sand	1·1 inch.
Black marsh soil	3·9 inches.
Clay loam (fine)	3·9 ,,
Clay loam (crumb form) ...	2·8 ,,
Dry peat	2·0 ,,

It will be seen that the coarser-grained texture produces a more effective mulch than one extremely fine. Coarse sand was the most effective. A comparison of the clay loams, one with a mulch in very fine condition and the other one in the form of small crumbs, shows the latter to be more effective; due, no doubt, partly to the finer mulch admitting less air between its particles, and also very quickly losing its function as a mulch by becoming connected with the soil below, instead of remaining as a comparatively dry layer on the surface.

Soil mulches lose their effectiveness very quickly after becoming wet either by rain or by watering. Gardeners know this quite well, and if plants in the open are watered during dry weather, the watering must be continued as long as the dry weather lasts. The watering has the effect of connecting the dried surface with the soil below, with the result that moisture is drawn from below and very quickly evaporated, leaving the soil very much drier.

Practical Application of Mulches.—*Cereal Crops.*—In many parts of Great Britain it is customary to sow the grain, harrow it in, and leave the surface rolled. This admits of great loss of moisture up to the time the leaves of the young cereal plants cover and shelter the soil. The crop often suffers from want of moisture at brairding time. The loss of moisture can be considerably reduced by lightly harrowing the rolled surface after it is sufficiently dry, but not before, and to such a depth as not to disturb the sprouting grain. In this way a mulch is formed on the surface, and the ascending moisture is imprisoned at the place where the grain is germinating, thus enabling it to get more quickly and more surely established.

Land for Turnips.—In the springtime, land which is intended for turnips is often left bare till all the other crops are sown. In dry weather the soil in this condition loses so much of its moisture that, by the time the land is ready for sowing, it might contain insufficient moisture for a successful braird. By lightly harrowing the turnip land in the spring the moisture will

be conserved, and the field can be left quite safely till the other crops are in.

Root Crops.—In many parts of Great Britain, although turnips are sown on drills, there is no attempt made to keep the drills well earthed up during the summertime. With turnip land worked pretty much on this system, the more frequently the soil is stirred during dry weather the better, and the less will the crop suffer from lack of moisture. The horse hoeing mulches the soil, and the frequent working prevents the surface layer from becoming connected with the soil below, and from thus losing so much water by evaporation. This principle is well known to British farmers, for they now regard it as a sound maxim in dry weather that 'the more the irons are among the turnips till the leaves cover the drills, the better'.

In conclusion, it is necessary to point out that mulches should be used with discretion. An effective mulch cannot be made until the surface soil is sufficiently dry. In Great Britain they can only be used to a limited extent, and it is only on soils which suffer from drought that they are of use. On soil which does not require mulching, they may keep it far too moist; but where crops suffer from drought in the summertime, early ploughing and mulching of the soil will conserve the soil moisture to a large extent and enable one to grow crops much more successfully. See also DRY FARMING. [J. Po.]

Mulching. — In conserving warmth and moisture, in checking the growth of weeds, in saving strawberries, &c., from being spoilt by contact with the earth, and as a method of applying manure to plants, this operation is of great value in the garden, and it might well be resorted to more often than is the case. Mulching is particularly helpful to recently planted trees and shrubs, and in enabling fruit trees which give promise of a heavy crop to perfect their fruits. Chaff, straw, short litter, spent tan, cocoanut fibre, rotten manure, and fresh dung are all valuable as mulches according to the effect desired, the last mentioned being applied to stimulate asparagus and other vegetable crops into early growth. Where mulching is objected to on the ground of appearances, the difficulty can be got over by spreading soil over the mulch. [W. W.]

Mule.—Although the term 'mule' is sometimes applied to the progeny resulting from crossing horses and asses, irrespective of the sexes of the parents, it is by the common consent of breeders now restricted to the offspring of the male ass or 'Jack' and the female horse or Mare; the converse cross of the male horse or stallion and the female ass or 'Jenny' being known as the 'jennet', 'hinny', or, especially in Ireland, as the 'mute'. Although jennets are fast trotters and possess great powers of endurance, as well as longevity, and although they have been extensively bred in Mayo, Cork, Tipperary, and other parts of Ireland, as well as in Italy, no great amount of care or attention has been paid to the stock, ordinary donkeys and ponies having been used for the most part for breeding purposes. It is commonly held by mule and jennet breeders that the donkey strain is prepotent over that of the horse whether the donkey be sire or dam. This certainly seems to be so with respect to mules; but it is not so markedly the case with regard to jennets, in which the characters of the two parents are more equally blended. This fact, coupled with inferiority in size, enables a practised eye to distinguish jennets from mules without much difficulty. If large she-asses, such as are now employed almost solely for breeding jacks, were paired with stallions of suitable size, there seems to be no reason why a breed of jennets rivalling mules in usefulness should not be produced.

The usefulness of mules depends in a great measure upon the circumstance that they combine in a remarkable degree the constitutional attributes of their parents on both sides. Descended originally from the species of wild ass inhabiting the rocky semi-desert areas of Nubia and Upper Egypt, where food is neither rich nor plentiful, and where the heat is excessive and the cold never severe, the jacks transmit to their hybrid progeny a faculty for resisting privation and for withstanding tropical heat which horses do not possess. Mares, on the contrary, are descended from one or more than one equine stock that, before being reclaimed by man from a wild state, roamed the plains or woods of Central Europe and Asia, and thus became adapted to the rigorous conditions prevailing in the winter in these temperate latitudes. From their asinine ancestry mules have inherited indifference to tropical conditions; and to their equine blood they owe their hardiness in resisting the cold of high altitudes and northern climes where donkeys do not thrive.

The value of mules as beasts of draught and burden cannot be overestimated. It has for long been fully realized in most parts of the world, although, in England, ignorance and prejudice have debarred their use on any extensive scale. The testimony of those who have had experience of both horses and mules is convincing as to the superiority of the latter animals where economy has to be considered and hard work done. They are longer lived, and able to withstand the effects of hard work for a greater number of years; they are constitutionally stronger, and less liable to the sicknesses to which horses are subject; they can be kept in vigour and health on coarser and cheaper food, and are therefore far less expensive to feed; they are hardier and able to resist extremes of temperature, especially of heat, of which horses are, comparatively speaking, intolerant; their narrow hoofs give them greater surefootedness than is found in horses, and enable them to pick their way with safety over mountain passes and by precipice edges which horses are afraid to traverse, or along which they cannot be led or driven without grave risk of disaster. Added to this mules have more caution, pluck, and perseverance than horses on difficult or dangerous ground, and are not less docile and tractable when managed with skill.

These all-round advantages of mules over horses in the way of economy of keep and working capacity outweigh the disadvantages with

respect to particular uses. For it must be conceded at once that the lightest mules are inferior in the matter of speed to good fast hackneys and trotters; and the heaviest draught mules fall short of Shire or Clydesdale horses in actual pulling power, by reason of their lighter build and lesser weight. The objection that is taken to mules on the score of bad temper and obstinacy may be dismissed by the remark that in the opinion of competent judges these so-called vices are the outcome of mismanagement and of cruelty towards beasts of a naturally nervous temperament which require above all things kindness and intelligence in handling.

In no part of the world has the importance of mules taken more practical shape than in the province of Poitou, in the west of France, where for several centuries the breeding of draught mules has been the principal occupation of the country peasantry. Although at the annual winter fairs held in this district, mules of different kinds are exhibited for sale, the breed for which this part of France is famous, the so-called Poitou mule, is the one that is most in evidence, and that is specially sought after by purchasers from America and elsewhere. A good Poitou mule stands about 16 hands at the withers, has a large and heavy head with long ears, a short neck, broad chest, muscular shoulder, capacious barrel, and above all, short and thick, but flat and hard legs, with large wide hoofs. It is upon the strength of the legs and the width of the hoofs that the value of this breed chiefly depends, for they are used almost wholly for ploughing and other heavy agricultural or road work, for which narrow-hoofed beasts are little fitted. Mules of this breed, which vary in colour from black to white, though the majority take after their jack sire in being some shade of dark-brown, fetch from £40 to £60 or even more, according to size and quality, when about three or four years old, whereas horses of comparatively the same capabilities fetch only about £30 or £40.

For producing mules of this description a special breed of asses has been developed by careful selective breeding. The chief points to be looked for in these Poitou asses are a head of great size, with large heavy ears, a long body, rough, shaggy coat, black or brown colour, greys being always rejected for stud purposes, and hoofs comparatively broad and much less contracted at the heel than is usually the case with asses. The height varies from about 13 hands in the females to 15 in the jacks. Good jacks are very valuable animals, and are seldom sold except at prices which are almost prohibitive. Cart mares standing from 15 to 16 hands are used for crossing with the jacks, and those that will take the ass and bear a mule are prized much more highly than those that can only be used for breeding their own species. Spanish or Catalonian jacks, which were brought to Spain by the Moors and are used in breeding Spanish mules, differ from Poitou jacks in much the same character as hackneys differ from cart horses. They are lighter in build, finer about the legs, and have the narrow hoof characteristic of their progenitors, the wild asses of north-east Africa. Similarly the Spanish mules bred from these jacks differ from the Poitou mules in lacking the sturdy limbs and broad hoofs of the latter breed. In Spanish mules the body is apt to be too large and weighty for the legs, giving them a top-heavy appearance; but if due care be taken to eliminate this defect by selecting a good Catalonian jack of about 14 hands for sire, and a mare of about 16 hands with a dash of the thoroughbred for dam, a magnificent mule of great beauty will be the result. Mules bred in this manner may equal the Poitou mule in height; but in accordance with their lighter build they are less suitable for very heavy work, although far more useful where speedy transport is required, on account of their trotting and galloping powers.

The Kentucky mules, which are famous all over America, owe their well-deserved reputation to the importation in the early half of the last century—between 1830 and 1840—of two Catalonian jacks, which were crossed with the ordinary female donkeys of the State and produced a most useful strain of mule-breeding jacks. It has been said, indeed, that all the best mules employed in North America at the present time owe their quality to this infusion of Spanish blood. However that may be, the immediate results obtained from them furnished convincing evidence of the value of well-bred mules. So highly appreciated indeed are these animals in the United States, that in 1889 over one hundred and fifty thousand were foaled, and the number is increasing every year, large quantities of jacks being imported from Spain and elsewhere for the purpose of breeding them. They are extensively used in the towns for heavy dock and railway work, and for lighter draught work of all kinds; in the mining districts for labour for which horses are less fitted; in the country for reaping, ploughing, and other agricultural pursuits; and in the army for transport. It is reckoned, in fact, that they can do almost every sort of work that was formerly performed by horses, and at a much cheaper rate, since three mules can be kept in working order on fodder that would supply only two horses, each comparable to a mule in working capacity. They are also invaluable as pack animals, for a good mule if judiciously loaded is capable of carrying over rough country a load of about 180 or 200 lb.

What is true of mules in America is true of these animals in other parts of the world. In South Africa, for example, teams of mules have been found superior to teams of oxen for wagon drawing; but it has also been found that they pull best if one of the leaders is a mare, for having been foaled and brought up by mares, mules have great affection for the company of horses and a corresponding dislike for that of asses. In India they are extensively used both as pack and draught animals in battery and other military work; and of late years careful attention has been paid to the breeding of serviceable animals in that country.

The question of the fertility of mules has been much discussed. It appears to be admitted on all hands that they are absolutely

sterile when paired together. This bar to the direct propagation of the stock is the one serious defect that can be alleged against these animals. Furthermore, the balance of evidence is strongly in favour of the commonly accepted view that mules are also infertile when paired with horses or asses. Those who incline to the contrary opinion base their belief upon the established fact that female mules have been found suckling foals, and that an animal formerly in the Jardin d'Acclimatation in Paris, and alleged to be a female mule, produced foals when crossed with horses and asses. Those on the contrary who hold that mules are completely sterile not only *inter se* but with the parent species, maintain that all cases of mules suckling foals are instances of abnormal lactation excited by the emotional influence of the maternal instinct; and justification for this view of the matter lies in the admitted fact that the phenomenon of abnormally induced lactation has been observed in several species of mammals, and is known to have occurred on more than one occasion in mule-mares which had adopted foals. As for the fertility of the Parisian mule, it has been pointed out that nothing was known of her ancestry; and, moreover, since her progeny by horses proved fertile while those begotten by asses were sterile, the conclusion that she was in reality a mule-like horse and not a true mule has much to be said in its favour. Nevertheless, since a good many instances are known to animal breeders of the progeny of distinct species proving occasionally fertile which were previously regarded as absolutely sterile, it would be rash to state dogmatically that mules never form fertile crosses with horses or asses. All that our present knowledge justifies us in saying is that up to the present time no undoubted case of this has been recorded; and that as a general rule such unions yield no result. [R. I. P.]

Mumps.—The infectious fever known as mumps in human subjects is not the same thing as commonly passes by that name in animals. A swelling of the parotid gland under the ear, and extending down between the jaw-bone and the neck, may arise from strangles (see STRANGLES), or from cold, or external violence, or the lodgment of foreign bodies in the duct. It gives rise to much inconvenience, causing the animal to poke out the head and experience some difficulty in swallowing. This parotitis, as it is more correctly called, may be a sequel to influenza or associated with other specific diseases, as tuberculosis and actinomycosis (see ACTINOMYCOSIS). Suppuration or the formation of abscess is indicated when the swelling becomes extremely painful and a soft place or 'point' threatens to break if not lanced, and matter is then liberated. *Treatment* varies according to the cause, but every effort should be made to prevent the structural changes which result from the formation of abscesses. Poultices, warm fomentations, iodine liniments, and such ammoniacal preparations as white oils, appear to cut short the malady and prevent pus formation. Bran mashes, porridge, pulped roots, and other soft foods should be offered. [H. L.]

Muriate of Potash.—This is the name given to the most largely used of the concentrated potash salts. It consists of more or less impure potassium chloride, KCl, and is made from the mineral carnallite (see POTASH MANURES). Carnallite is found in enormous quantities in the German potash deposits, and practically the whole of our supplies of muriate of potash are derived from it. It is a compound of the chlorides of potassium and magnesium with water ($KCl.MgCl_2.6H_2O$), and is found mixed with common salt and kieserite. About 2½ million tons of carnallite are mined annually, and nearly the whole of this is used for the manufacture of muriate of potash. A little carnallite is used in the crude state as manure, but as it is a hygroscopic it is not a popular manure.

Muriate of potash is prepared from carnallite by a comparatively simple process of solution and recrystallization. The carnallite is dissolved in a hot saturated solution of chloride of magnesium, which on cooling in crystallizing pans deposits crude muriate of potash. The crystals are separated from the mother liquor and washed with cold water. This is in outline the process by which commercial muriate of potash is obtained. In practice the process is elaborated more or less in its details. The muriate of potash so obtained contains from 70 to 98 per cent of pure potassium chloride. The principal impurity is common salt, of which from traces to over 20 per cent may be present. Small quantities of magnesium chloride, magnesium sulphate, water, and other substances are also present.

The production of muriate of potash, like that of the other important potash manures, has increased with great rapidity during the past twenty-five years. This is shown by the following figures:—

PRODUCTION OF MURIATE OF POTASH IN GERMANY

1880	96,832 tons.
1885	104,500 ,,
1890	134,760 ,,
1895	145,027 ,,
1900	206,471 ,,
1906	259,163 ,,

This increase though rapid is not nearly so great as in the case of kainite, nor does it really represent the whole truth. The substances known as 'potash manure salts' are really impure varieties of muriate of potash (see POTASH MANURE SALTS). They began to be used in quantity only about 1880, when the production was 9500 tons. In 1906 the production was 276,689 tons.

Muriate of potash is used both for agricultural and industrial purposes. Great quantities are used for the manufacture of caustic potash, nitrate of potash, chromate of potash, chlorates, and other products. In Germany itself comparatively little is used as manure, while very large quantities are used for manufacturing purposes. In other countries, though great quantities are used for manufacturing purposes, about two-thirds of the total export is used for agricultural purposes

Pure potassium chloride contains the equivalent of 63·1 per cent of potash, but the standard muriate of potash of commerce is only 80 per cent pure, that is, contains only 80 per cent of pure potassium chloride, and is therefore equivalent to 50·5 per cent of potash. Muriate of potash is ordinarily quoted and sold in the market on the basis of 80 per cent purity. That is, the price per ton quoted for muriate of potash in market reports is on the assumption that the muriate is of 80 per cent purity and contains the equivalent of 50·5 per cent of potash. As already stated, muriate of potash varies considerably in purity, and different qualities from 70 to 98 per cent pure are produced. The prices of these vary according to their purity. The price for 80 per cent pure is taken as the standard, and the other ordinary qualities cost more or less in proportion to the percentage of potash.

As muriate of potash is a manufactured article, it costs a little more per unit of potash at the point of production than a crude salt like kainite. On the other hand, the further we get away from the point of production the cheaper relatively does the potash in muriate become as compared with the crude salts. This is on account of the cost of carriage. One ton of muriate of standard quality contains as much potash as 4 tons of kainite, for kainite contains only about 12·5 per cent of potash (see KAINITE), while muriate of potash of standard quality contains 50·5 per cent. It is largely on this account that muriate of potash is little used as a manure in Germany, for there, near the point of production, the crude salts are cheaper sources of potash; and on the other hand, muriate is largely used as a manure, and crude salts are comparatively little used, in places remote from Germany. Even in this country, if the prices are compared it will be found that muriate of potash is a rather cheaper source of potash than kainite, for 1 ton of muriate is equivalent in potash to 4 tons of kainite, while the price is not four times as great.

Muriate of potash may be used for all crops as a potash manure. High-grade sulphate of potash is the only other potash manure equal to it in concentration, and muriate has the advantage over sulphate of potash that it is rather cheaper per unit of potash. On the other hand, the results of experiments indicate that sulphate of potash, when used as a manure for the potato crop, gives tubers of rather better quality than muriate of potash. So far as quantity of crop goes, there is little to choose between muriate and sulphate of potash as manure for the potato crop. In the case of all our other ordinary crops there does not appear to be any great difference between sulphate and muriate of potash, weight for weight of potash, in regard either to quantity or quality. The muriate of potash is therefore to be preferred, as it is cheaper weight for weight of potash.

In comparing muriate of potash with kainite we have to take into account the fact that kainite contains a large amount of common salt and of the sulphate and chloride of magnesia. See KAINITE. [J. H.]

Murrain. See CATTLE PLAGUE and RINDERPEST.

Musca, a small genus of flies of which two are found in Britain, namely *M. domestica* and *M. corvina*. The former is the Common House Fly.

M. corvina, Fab., is a fly which is said to breed in rotten cheese, and is abundant from spring to autumn inside of windows, in gardens, &c. It expands ½ in., and is bristly, but the sexes are very dissimilar. The male is deep-black; eyes brown, body ochreous, the base, and a stripe down the middle, black. The female is silvery-grey, with a black stripe on the crown and four on the thorax; the body is tessellated with black, and the legs are black. It differs in many respects from the Common House Fly. It only lays about twenty-four eggs, which are much larger than those of *M. domestica*.

M. domestica, Linn. (the House Fly), is exceedingly numerous in houses, barracks, refreshment rooms, &c., soiling the windows, blinds, bed hangings, &c., especially when they are white, and food of all kinds. The maggots are hatched in moist dunghills, &c., where they are transformed into flies, horse manure especially being chosen. The length of the House Fly is about ¼ in., the face silky-white, with a black stripe on the crown; thorax grey, with four black stripes; scutel grey; body ashy or ochreous, with the extremity ash colour, and a blackish stripe down the middle; wings ochreous at the base. The eggs, of which a female may deposit as many as 150 in a single batch, are white in colour, elongated at one end, rounded at the other. During the fly's lifetime it may deposit six or more batches, Jesson says in bundles of 50. They hatch in warm weather in less than a day into small greyish grubs, pointed at the head end, swollen at the tail, which is bluntly truncated, and which bears two tracheal openings; on the third segment from the head are two lateral processes, terminating in seven round bodies forming a uniform border. They are tracheal processes. According to Hewitt, the ova may hatch in from eight to twenty-four hours. In from five to eleven days the larvæ mature and reach the length of nearly ½ in. There are three larval stages, the larva moulting twice. The pupal stage is passed in a brown puparium of elongated oval form; at the anterior end on each side is the remnant of the anterior spiracles. This stage lasts three to eighteen days. Thus a generation takes from eight to thirty days to mature. The rate of development is proportional to the temperature. There are certainly four or more broods in Britain in the year; in the southern American States as many as fourteen seem to occur.

This house fly occurs in woods and outhouses and stables as well as in man's dwellings. The part the flies play in spreading such a disease as enteric fever is very important. The adult flies feed upon the moisture not only of food, but of human and other excreta. In this way the germs of the disease are carried on the feet and body of the flies to our food and even drink. Outdoor privies and latrines should always be carefully attended to, so that no undue exposure is allowed.

They winter in the adult stage behind the paper of walls, &c., and may even breed in winter.

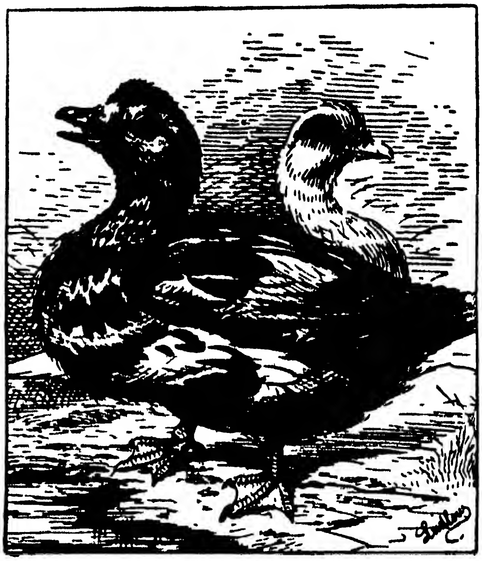
The breeding ground of house flies can usually be traced to some stable-manure heap near by, but they may also live in cow dung; also in spent hops, poultry dung, human excrement, woollen garments, and paper fouled by excrement. Closed bins should be used for horse manure, and the manure frequently removed.

House refuse and all excremental substances should not be deposited near houses. What can be burnt should be destroyed at once. [F. V. T.]

Muscidæ, a family of two-winged flies to which belong the House Fly (*Musca domestica*), Blue-bottle Flies (Calliphora), Green-bottle Flies (Lucilia), Storm Flies (Stomoxys), Horse Flies (Hæmatobia), and others. These and others are not only annoying to man by defiling his food and surroundings and by producing irritation, but they may carry disease germs (enteric fever). Meat and other products are attacked by Blue-bottle Flies, and sheep and other stock by the Green-bottle Flies. The Storm Fly and Horse Flies are bloodsuckers. The larva or maggot of these Muscidæ is in the form of a white footless grub, tapering to a point at the head end and truncated at the tail end; they are repulsive-looking creatures of moist appearance (gentles). The larvæ live in all manner of places, such as horse manure, vegetable refuse, soil, on animals and dead animal flesh. The pupal stage is formed in a brown puparium. [F. V. T.]

Muscovite, or white mica, is described under the art. MICAS

Muscovy Duck, one of the oldest races of ducks, which has not, as its name would indicate, any connection with Russia, but is a native of South America, where it is very widely distributed. It has been known in Europe for nearly 250 years, and its introduction was one of the results of the discovery of America by the Spaniards. It has been suggested that the name is a corruption of the term 'musk', due to the fact that there is a peculiar odour emitted by the flesh of the birds when they are old. It is very long in body and boat-shaped, fine in bone, carrying a large quantity of flesh, which is fairly good for the table, though somewhat highly flavoured. This only applies to young birds, as the older specimens are very tough. They are excellent foragers, and can be kept under almost any conditions. They are not very good layers, and are mainly kept for table purposes. One peculiarity is that around the eye upon the face the flesh is entirely bare of feathers and bright-red, and on the front of the head is a large knob of flesh which, with the featherless face, gives it a somewhat raw appearance. The wings are large and strong, as might be anticipated by the quantity of flesh carried upon the breast. These birds grow to a great size, frequently reaching 12 lb. The fact is that in respect to qualities they have many points in their favour, and some of their weaknesses could have been modified by breeding; but the reason why the Muscovy duck has never attained any measure of popularity is simply due to its vile temper. No other denizens of the poultry yard can live peaceably with this breed, and for that



Muscovy Duck

reason many of those who kept it at one period have had to give it up. [E. B.]

Muscular System. See PHYSIOLOGY OF FARM ANIMALS.

Mushrooms. — Mushrooms belong to a group of fungi of which there are numerous species similar to one another in general structure and appearance, to such a marked degree that only an experienced cryptogamist can detect the cultivated variety among others of

Fig. 1 Fig 2

similar form. Mushrooms are merely the spore-producing organs of the plant, which assume a dense mass of netlike filaments below the ground where the soil contains an excess of humus and decaying vegetable matter. The spore-bearers, or mushrooms in the ordinary sense, are usually cap-shaped, and are supported on a short, thick stem. In Agaricus, the genus to which the great majority of mushrooms belong, the under surface of the cap is studded with numerous thin plates (gills) radiating from the stem to the circumference, and in the sides of these the spores are formed. These gills may be continued unbroken into the stem, or separated from it by a narrow

space. These and other variations, including the colour of the spores, and the presence or absence of a membranous lining, which in young mushrooms pass from the edge of the cap to a ring round the stalk, constitute important characters in determining the genus and species to which the many varieties belong.

The cultivated mushroom differs somewhat from the Field Mushroom, *Agaricus campestris* (fig 1). It is distinguished by botanists as *Agaricus hortensis*, and is described as a compact and inferior form of the field variety. *Agaricus arvensis*, the Meadow or Horse Mushroom, is found growing in similar positions to the Field Mushroom, but is considerably larger; the cap is pure-white in colour when young, and it has paler gills than *A. campestris*. *A. gambosus*, commonly known as St. George's Mushroom (fig. 2), is an edible variety of fine flavour, and is often abundant in early spring; the cap is nearly white, and the gills of a pale-yellowish colour, while the stalk is devoid of a

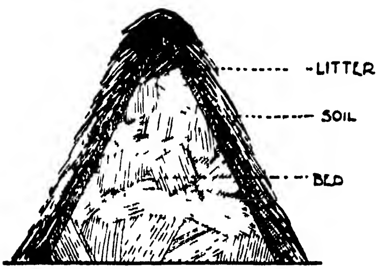


Fig. 3

ring. Numerous other varieties of the genus Agaricus are recognized in Britain as edible, but it does not behove the inexperienced to experiment in their use as food, as so many of the species are highly poisonous, one of the most dangerous in this respect being *A. fustibilis*, also the allied species *crustuliniformis*. Their objectional odour is, however, sufficient to condemn them. The true mushroom is never very large, the cap rarely exceeding 4 or 5 in. in diameter, its colour being of a somewhat metallic white. The gills are soft and pink in colour, and a crucial test is the ease with which the outer skin may be peeled off, leaving a pure-white surface below.

A high temperature, especially throughout the night, and abundant moisture are important points in the growth of mushrooms. The enormous quantities which become available for market purposes during the months of July, August, and September do more than glut the market; hence for purposes of a pecuniary consideration they are more extensively cultivated in winter and spring than in the other seasons of the year. In the summertime a ready supply is always obtainable from the woods and pastures, while in winter and spring the markets are dependent upon the cultivated crops.

A variety of conditions are requisite for the production of a good crop: the preparation of suitable manure, the quality of the spawn, conditions when made into beds, and the proper temperature throughout the various stages of development all conduce towards good or bad results; and while splendid crops are secured with merely ordinary attention, it frequently happens that unfavourable conditions of soil, climate, and natural temperature have disastrous influences, even where the keenest and most careful attention is paid.

For indoor cultivation an underground cellar or cool outhouse can be well utilized, though good crops are secured in the open by constructing ridges about 3 ft. wide at the bottom (fig. 3). Fresh horse manure forms an admirable dressing for mushroom culture, but should be well rotted to a fine consistency. Pieces of spawn about 2 in. square should be inserted in holes placed about 9 or 10 in. apart. A layer of good fresh maiden loam should then be spread over the sides of the bed, and this in turn should be protected from light by a covering of horse litter or straw. Under favourable circumstances the mushrooms will make their appearance at the end of six weeks, and at this stage the straw covering must be removed and a careful watering given, the temperature of the water being raised to about 80° F. In order to sustain a moist humid atmosphere, the interior of the shed should be frequently syringed, especially where fire heat becomes necessary. [J. C. N.]

Mushrooms, Diseases of.—The conditions of cultivation, especially in cellars, tunnels, or other moist heated places with little ventilation, are extremely favourable to the growth of 'weed fungi', several of which may become parasites on the mushroom crop; various insects also become destructive. One common disease converts the mushroom into a shapeless mass with a small deformed mushroom-cap at one end. This is the work of a minute fungus (*Hypomyces*) which penetrates the young button mushrooms, and appears as a snowy, velvety covering on the deformed mushrooms, so that they soon become an evil-smelling putrid mass (Board of Agriculture Leaflet No. 139). Another disease (*Xylaria*) originates from tiny black fungus-bodies bearing numerous branches from which fungus-spores are liberated. The cracking of mushroom caps and other troubles are also probably due either to fungi or insects.

Treatment.—If a destructive epidemic appears in a mushroom bed, the only remedy is to clear away infected beds and begin afresh. All soil, &c., used should be kept from contamination by remains of mouldy spawn-beds. Before laying down new spawn all parts of the house should be cleansed; spraying with lysol (2 or 3 parts in 100 parts water) has been recommended. Properly constructed mushroom houses may be sufficiently heated and at the same time be ventilated by fresh air admitted low down near the heating apparatus, while the impure air escapes near the roof. Open-air beds are less liable to disease, but mats, &c., used as covers should be clean, and ventilation promoted. [W. G. S.]

Musk, the name given to a number of different plants which emit the familiar musky odour, *e.g.* Musk Mallow, Musk Melon, Musk Rose.

Musk Beetle, a beetle 1½ in. long, and of a bright metallic-green colour. See AROMIA MOSCHATA.

Musk Ox (*Ovibos moschatus*), a large, heavily built ruminant, intermediate in size between sheep and cattle, and confined in its distribution to the Arctic regions of North America. Despite its name the Musk Ox is not closely related to the true cattle, but claims kinship rather with the sheep and their allies, as is shown by the structure of its molar teeth; and it has been suggested that its nearest living ally is a peculiar ruminant, the Takin (*Budorcas taxicolor*), which inhabits parts of the eastern Himalayas and South China. The relationship, however, is not close to any ruminant, either living or extinct. In the bulls the horns are very wide at the tips and close at the base, forming a kind of helmet on the front of the head. They then bend sharply downwards behind the eye, then outwards and upwards. In the cows the horns are much smaller and are separated at the base. The muzzle is hairy; and the coat, which has abundant underwool, is long, coarse, and shaggy, and reaches below the knees and hocks. The tail is quite short; and as an adaptation to the snow-covered areas in which the species lives, the hoofs are broad and have hair projecting between them to ensure a firm foothold on slippery ground. Musk ox live in herds, and are wonderfully agile despite their weight of about 500 lb. For their skins and flesh they are hunted by the Eskimos, who train their dogs especially for the chase; but they are savage beasts when brought to bay, fighting desperately with horns and hoofs, and are difficult to kill without firearms. The name is derived from the musky odour they emit, and a flavour of this substance pervades the flesh unless the skin is stripped immediately after death. Although formerly found all over Northern Europe and North Asia, musk ox are now confined to Arctic America east of the Mackenzie River, and Greenland. [R. I. P.]

Musmon, a species of wild sheep. See MOUFLON.

Mussel Scale, a scale insect of the Coccid family, and one of the worst pests in the fruit garden. See MYTILASPIS POMORUM.

Mustang.—The name Mustang as applied to the wild, or comparatively wild, horses of America is doubtless familiar to all who have studied the earlier history of the great transatlantic continent, but at the present day it is very seldom used or seen, and it would be a very difficult matter for the ordinary man to locate a true Mustang. The march of civilization and the success of the efforts which have from time to time been made to improve the horses of America are, of course, responsible for the practical extinction of the original Mustang, and it may be added that his origin is equally obscure. A belief prevails in some quarters that there were Mustangs found in America by the Pilgrim Fathers when they landed from the 'Mayflower', and that these were descendants of horses left behind by Columbus or some of his immediate successors who crossed the Atlantic; but the balance of evidence goes to show that there were no horses found in America when the explorers first landed. Since these remote days, however, it is certain that the vast majority of the horses of the prairies have been improved by the introduction of European and Eastern blood, and hence the modern Mustang must be a very different animal to what he was a century and more ago. If he is to be judged by the specimens which are seen in this country in association with Wild West and similar displays, he is a rather narrow stamp of cob, inclined to be light in bone, and not particularly neat about the head. On the other hand, the specimens referred to have usually very good riding shoulders, as these are long and laid well back. Their action, too, is well adapted for saddle work, it being more of the nature of an easy swinging amble than of a canter. The result is not particularly graceful to look at, but the gait is essentially a comfortable one for the rider, and very easy for the horse. Hence the natural stamina of the Mustang, or Broncho as some people style him, is materially assisted when, as is often the case, he is called upon to carry his rider over long distances with very little in the way of nourishing food or water to support his strength. [V. S.]

Mustard.—Two species of Mustard are commonly cultivated, viz.: (1) Black or Brown Mustard (*Brassica nigra*, Koch), and (2) White Mustard (*B. alba*, Boiss.) (see art. BRASSICA).

1. BLACK OR BROWN MUSTARD is an annual grown only for its seeds, which yield an oil or are ground into flour; the latter, after removal of the pieces of dark brownish-red seedcoats, is used chiefly as a table condiment mixed with water or vinegar.

It is a wild British species, somewhat resembling Charlock in many of its characters, and grows to a height of 2 ft. or more. The stems are more or less rough, slightly glaucous, the lower leaves lyrate, rough, with large terminal lobes, the upper ones lanceolate and entire. The flowers are yellow; the pods are smooth, ½ to ¾ in. long, and when ripe closely appressed to the stem.

The seeds are small, oval, brownish-red when harvested under good conditions, but become grey if allowed to get wet and heated; they have a pungent biting taste. From them about 22 per cent of a mild-tasting fixed oil, somewhat resembling 'colza', can be extracted by pressure; the refuse 'oilcake' is not adapted for feeding purposes, but is useful as manure. The seeds contain a glucoside, potassium myronate, and an enzyme or ferment, myrosin; the latter in the presence of cold water decomposes the potassium myronate, with the formation of 'mustard oil' or allylthiocarbamide—a compound having an exceedingly pungent taste and odour, and capable of producing blisters when applied to the skin. Hot water checks this reaction by coagulating the ferment, hence mustard poultices should be prepared with cold water.

Black Mustard grows best on good fertile loams, and is often taken as the first crop after breaking up grassland. After preparation of a fine tilth the seed is sown broadcast in March

or April at the rate of about ½ peck per acre. It should be lightly harrowed in so as not to bury it too deeply, or much of it may not germinate in that season. The plants are thinned out with the hoe early in May; plenty of space should be given to those left, so as to allow of their vigorous growth and strong branching, without which a good yield of seed cannot be obtained; a crowded crop is always deficient in seed production. The crop is ready early in September. Great watchfulness is necessary at this period to determine the proper time to commence harvesting operations. It should be cut with a broad hook, when the lower pods on the flowering stems are beginning to turn brown; if left longer, the pods open and seed is shed and lost.

Seed scattered in this way leads to much trouble, in that it germinates and produces an army of weeds in subsequent crops for several years afterwards. The fear of this led many landlords to insert a clause in their covenants prohibiting the cultivation of Black Mustard. The partially green crop, which readily ripens its seeds after being cut, is tied into sheaves or laid in handfuls on the stubble. After drying for three or four days it is then carried in carts covered with cloths to prevent loss of seed, and carefully stacked against rain. The crop may be thrashed by hand on cloths in the field, or by machinery at home.

The average yield is about 25 bus.

2. WHITE MUSTARD is an annual species, but apparently not native in the British Islands. It is sometimes grown for its seeds, and in gardens as a salad mixed with cress (*Lepidium sativum*). It is, however, grown chiefly on the farm as green fodder for sheep or for ploughing-in as green manure.

The stems are furrowed and hispid, stronger and taller than those of Black Mustard, and the leaves are pinnatifid, the segments being lobed and rough. The pale-yellow flowers give rise to spreading pods, short, rough, with a characteristic dagger-shaped curved beak. The seeds are much larger than those of its relative, and whitish-yellow. They contain about 25 per cent of a mild fixed oil, and when ground and mixed with water, develop a slightly different mustard oil, which is not so pungent as that from Black Mustard seeds.

When seed is required, broadcast sowing on rich land must be adopted, or drilling in March in rows 12 in. apart at the rate of 12 to 18 lb. of seed per acre. Harvest takes place in September, the crop being cut and dealt with as described for Black Mustard.

White Mustard is one of the most important plants available for subsidiary or catch cropping between those of the ordinary rotation. It will grow for this purpose on a great variety of soils, and is very rapid in developing, often attaining a height of 2 or 3 ft. in six or eight weeks from the time of sowing when conditions are favourable. After peas, beans, vetches, and potatoes, or in cases where turnips or rape have failed, it may be grown with success, yielding valuable nutritious green food containing about 83 per cent of water, 7½ of carbohydrates, 2 of protein, and 6 of fibre.

The land should be reduced to a fine state and the seed sown broadcast any time between April and August. It is usually ready for folding with sheep in about eight or nine weeks, and should be consumed before flowering sets in, or the plants become fibrous and woody and lose much of their feeding value. On many classes of soil, when grown and ploughed-in as green manure it proves of great benefit to the land. It improves the tilth of clay soils, allows of better drainage, and indirectly warms it, while on the lighter gravels and sands deficient in vegetable matter it adds the latter, and helps to absorb and retain moisture in dry seasons for the benefit of wheat and other subsequent crops. For green manuring, seed is sown broadcast, 18 or 20 lb. per acre, in July or August, and the crop ploughed in during October or November, when it is succulent, and 12 to 18 in. high. To cover it properly it is generally necessary to run a roller over the crop in the direction in which the plough follows, and attach a chain and weight to the coulter of the plough in such a manner that the weight may trail along the bottom of the previous furrow about the middle of the mouldboard. [J. P.]

Mustard Beetle—also called the Black-jack—a beetle of 1½ to 2 lines long, dark-green or deep-blue in colour, and oval in form. It is very destructive in certain districts to turnip, rape, and mustard. See PHÆDON BETULÆ.

Mustard Blossom Beetle. This insect pest is described in the art. MELIGETHES ÆNEAS.

Mustard weeds is a term applied by agriculturists to certain yellow-flowered annual cruciferous weeds which resemble the cultivated mustard.

Two quite distinct kinds of mustard weeds are troublesome in grain crops:—

1. CHARLOCK, Kedlock, Skelloch, or Wild Mustard (*Sinapis arvensis*).

2. RUNCH, Jointed Charlock, or Wild Radish (*Raphanus Raphanistrum*).

Runch is a much hardier and more robust plant than Charlock. Attention to the following points of difference renders distinction easy.

	Charlock.	Runch.
Leaf-blade ...	Comparatively simple.	Cut into distinct pieces (compound leaf).
Flower—Sepals ...	Spread out horizontally.	Erect.
Petals ...	Yellow, when withered still yellow.	With violet veins, when withered white.
Fruit	A pod (*siliqua*), opening by two valves to allow seed escape.	Not a pod. It never opens, but is jointed and splits across into pieces, each piece containing one seed enclosed within (*lomentum*).

These mustard weeds are very troublesome in the grain crop, and more especially on light

land. In summer, one often sees fields of corn covered with yellow blossoms which readily catch the eye, and the crop appears more like mustard or rape than corn. Such appearances are due to the presence of the mustard weeds, and are most in evidence when the season is unfavourable to the growth of the grain crop. It is important to notice that these weeds can originate only from seeds, so that if seeding is prevented, and if no seeds are in the land, the crop will be free from mustard weeds. Nevertheless, many cases are known in which these weeds have appeared on fields which have been broken up after lying in grass for many years. Such outbreaks are explained when we know that the seeds have the property of lying dormant in the depths of the soil for many years without losing their vitality, and that when these buried seeds are brought to the surface they can start into active life.

Another important point in relation to the means now adopted for the destruction of these weeds is the spread of the leaf in the horizontal direction, whereas in the grain crop the leaf is more vertical and twisted into a spiral. Accordingly, if a spray be applied to a grain crop infested with mustard weeds, the spray will readily run off the crop plants, and tend to stick to the mustard weeds This tendency is increased in the case of the mustard weeds by the fact that the leaf is covered with hairs which stand out at right angles to the surface, and thus act as centres of attraction for the spray; whereas in the grain crop any tendency to adhere is diminished by the waxy coating spread over the leaf surface. The action of a poisonous spray is thus very different on the crop plant and on the mustard weed associated with it. Experiment shows that the tips of the corn leaves are alone affected, and only temporarily, for the browning effect soon passes away; whereas the browning effect on the leaves of the mustard weed is permanent—in fact the leaf is killed, or weakened to such an extent that the weed has not the wherewithal to manufacture flower and seed; thus seeding is prevented.

Two reasons indicate the advisability of applying the spray at an early stage of growth. One reason is that the potency of the poison in the spray depends on its power of soaking into the interior of the leaf, and of course the young leaf will be more susceptible, for at an early stage the corky layer of cuticle which would retard entrance is less fully developed on the surface of the leaf than at a later stage.

Another reason is that early spraying minimizes the damage to the grain crop. The early spraying renders the mustard weed incapable of competing successfully, for its roots are checked in their growth and in their powers of absorbing from the soil, and besides, the leaves are so stunted that they interfere very little with the growth of the grain crop. The amount of damage done to a grain crop when the mustard weeds are allowed to grow up unchecked till the flowering stage is reached, can hardly be realized by anyone who is not familiar with experiments carried out expressly to test the point. Early spraying prevents seeding, and allows the grain crop to give full yield, whereas late spraying only prevents seeding.

It is important to notice further that the roots of mustard weeds harbour the parasitic fungus (*Plasmodiophora Brassicæ*) which causes the disease known as 'finger-and-toe' in turnips. Thus, by checking the mustard weeds at the proper time, we not only secure better grain crops, but our turnips are less liable to be affected by 'finger-and-toe'. [A. N. M'A.]

It has now been proved in numerous experiments that these mustard weeds can be successfully destroyed by spraying them with solutions of certain poisonous substances. The substances found most effective are sulphate of copper (blue vitriol or bluestone) and sulphate of iron (green vitriol), but the former has usually given the best results, and is the one generally employed. The dressing is applied by means of a spraying machine, in a solution containing not less than 3 per cent nor more than 5 per cent sulphate of copper. The 3-per-cent solution has been found effective in dry climates and at an early stage in the growth of the weeds; but in wetter climates, and applied after the mustard weeds have attained to some strength, it requires a 4- and sometimes even a 5-per-cent solution to destroy them completely. Sulphate of iron, if preferred, must be employed in solutions of twice these strengths. The solutions require to be applied at the rate of 50 gal. per acre, which is found to be sufficient to give the whole crop a uniform and complete spraying. A single spraying applied at the right time will frequently destroy the greater part of the weeds, but the safest practice is to spray twice at an interval of ten days or a fortnight. The second application destroys any plants that have survived or escaped the first, and is especially required to destroy those weeds that have come later through the ground. It is very important, as has been already explained, that the first spraying should be done at an early stage in the growth of the weeds. The proper time is just when they have developed rough leaves. It is important also that the spraying should be done in somewhat dry weather. Should heavy rain fall soon after, the spray is liable to be washed off the plants before it has sufficiently damaged them, and it may largely fail in its effects. But if done at the proper time and in suitable weather, it may destroy almost every mustard weed in a crop.

The cost of spraying varies with the price of copper and the rate of wages paid for labour. But generally it may be taken to amount to not more than 7*s.* per acre for a 3-per-cent spraying; but many farmers do not attempt the operation, because they remain in doubt as to whether the advantage gained will be enough to recoup them for the expense incurred. Experiments to determine this have been carried out by the writer for a number of years on the West of Scotland Experiment Station, and the results in the years 1902 and 1903 may be quoted. On the average of the two seasons, an oat crop which was twice sprayed with a 3-per-cent

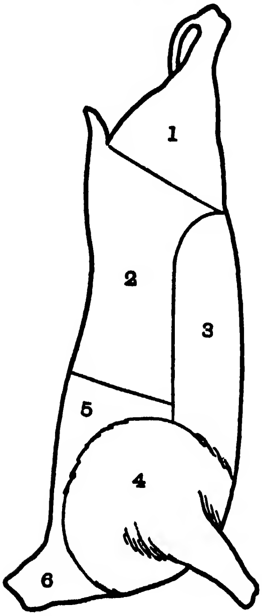
solution of sulphate of copper gave a yield per acre of 69 bus. dressed grain, 7 bus. light grain, and 45½ cwt. straw; while the unsprayed plots yielded only 47 bus. dressed grain, 4 bus. light grain, and 35¾ cwt. straw. The increase of crop resulting from the destruction of the mustard weeds amounted therefore to 24 bus. dressed grain, 3 bus. light grain, and 9¾ cwt. straw. It was estimated by farmers who inspected the crops before harvest that the sprayed crops were worth about twice as much as the unsprayed, and the results showed an increase of crop of the value of about £4 per acre, obtained for an expenditure of about 14*s*. There could be no question in this case about the profitableness of the spraying. But it must be borne in mind that these experiments were carried out in a field which was very thickly occupied by the mustard weeds, and in which the growth of the oat crop was obviously much damaged by them. A similar improvement in yield could not be expected on fields in which the proportion of mustard weeds was relatively small. But whenever the mustard weeds are so numerous as to interfere at all seriously with the growth of the crop, it is apparent from these results that spraying will prove a most profitable operation, provided it be so done as to destroy the whole or the greater part of the objectionable plants. These results have proved that the damage done to a corn crop by such weeds is much greater than could easily be believed. This may be attributed to their very rapid growth at a time when the young oat plants are just beginning to establish themselves in the soil, to their consequent rapid absorption from the soil of soluble substances which the corn plants equally require, and to their effect in shading the young oat plants and depriving them of light, and of impeding the free circulation of air about and among them. But in dry seasons, and especially on light soils, perhaps the greatest amount of damage is done to the corn crop by the stronger demand made by these weeds on the moisture in the surface soil, which they suck up in large quantities and exhale rapidly into the atmosphere through their broad leaves. See also arts. SPRAYING, CHARLOCK, and RUNCH. [R. P. W.]

Mutton is the flesh of young sheep, ewes, and rams. In young well-fed animals the flesh is less florid in colour, and is finer in the grain than that of the ox; but the flesh of the old ram, especially if he has been poorly fed, is dark, and coarse in the grain; it is inferior in quality, and is tough and stringy. Old ewes and rams, if well fed, have a tendency to deposit considerable quantities of subcutaneous fat about the shoulders, loins, and root of the tail. This causes the butcher to trim away the superfluous fat, and reduces his profit. Some young sheep have a similar tendency to deposit fat when well fed. It is therefore in the interests of the breeder, feeder, and butcher that the proper class of sheep should be selected to suit all parties. The desirable sheep is one that comes quickly to maturity, giving to its feeder the best and quickest return for money spent on feeding, and which deposits the fat uniformly over its body. To produce a sheep of this class many breeds have been crossed, some farmers favouring one cross, some another. In Scotland a very useful and profitable cross is the so-called 'Cross-bred', the result of mating a cast hill (Blackface) ewe with a Border Leicester ram. Such sheep come quickly to maturity, do not become too fat, are a useful size, and are therefore well suited for the butcher. In England many crosses have been tried, but a good Hampshire Down is still hard to beat. The Oxford Down, a modern variety, is the result of mating the Cotswold with the Hampshire Down. This sheep comes quickly to maturity, sells well as a lamb, but has a tendency to become too heavy when kept until a shearling. Time was when the Cheviot, along with the mountain breeds of Scotland and Wales, held the field. Even yet these breeds, when properly fed, are hard to beat, as is shown by the fact that Mr. M'Dowall, at the Carcass Competition at the Smithfield Show in 1908, came out at the top. On his native hills the Cheviot takes some time to mature; indeed, like the Blackface, he used to be considered only at his best when three or four years old. Times change, and now the breeder desires cash for his sheep as soon as it is a 'shearling'.

A useful carcass of mutton should be short-legged, plump, full of meat, and not too fat. The neck should be as short as possible and thick, while the body should be round, in order to have as little flank as is consistent with the form of the animal. The shoulders and legs should be thick, and full of meat right down to the knee or the hock; the loins thick and fairly well covered with fat, and on section they should show a full 'eye', *i.e.* plenty of lean meat in the chop. A butcher can generally tell that a carcass of mutton will cut 'fleshy' if, though well covered with fat, he can see the lean flesh shining through the panniculus just where the neck ends and the shoulder blades (scapulæ) approximate each other. Carcasses vary in weight from 45 to 100 lb. or over, depending on maturity, breed, and age, a useful weight being from 56 to 70 lb. Mutton improves by keeping, and a leg may be 'hung' a considerable time, when it is found to eat very tender. The flesh of the sheep is more free from disease than that of the ox or pig, tuberculosis being so rare in sheep as to be considered negligible. The fat of mutton is whitish in colour (except in heredity cases, where it may be yellow and the carcass quite healthy); the consistency is much firmer than that of beef fat; it is almost completely odourless, has a high melting-point at from 31° to 52° C., with a very large proportion of stearin in it. The method of cutting up a carcass of mutton varies with the town or district. The accompanying diagram shows the London method. The two loins joined are called a 'saddle of mutton'. The two scrags joined are called a 'chine of mutton'.

The joints are used in various ways according to localities. In London, legs and shoulders are roasted, and so is the saddle, but the loin is generally cut into chops. In some towns where there is a great demand for chops, the shoulders and legs are also cut up for that purpose; flanks

and breasts are used for stewing purposes or soup making, or may be boiled and eaten when cold. In some districts the legs are salted and made into hams, while some butchers make



1, Leg. 2, Loin. 3, Breast and flank. 4, Shoulder 5, Best end neck of mutton. 6, Scrag end.

mutton sausages a speciality. The carcass of a goat may be substituted for that of a sheep, but may be distinguished by the musculature being generally darker in colour. There is little if any subcutaneous fat, and there is also a disagreeable odour which is characteristic. The fat is deposited peri-renal, and the subcutis has a peculiar sticky feeling; the hairs from the skin often adhere to it, thus helping to detect the origin of the meat. To distinguish frozen and chilled mutton from home-killed mutton, see BEEF, FROZEN MEAT, &c. [T. D. Y.]

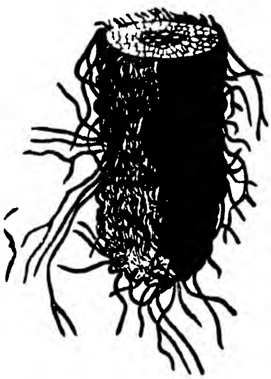
Muzzling Order. See art. DOG.

Mycelium, the filamentous, vegetative portion of a fungus. See FUNGI.

Mycetophilidæ (Fungus Gnats). — The Fungus Gnats form a very abundant family, and occur at all times of the year. They often appear in great numbers on windows in houses. Most lay their ova in fungi or decaying wood. Several are highly injurious to mushrooms, whole frames being destroyed by the white footless grubs of these insects. Wild mushrooms are also often spoiled by them. The larvæ are gregarious, and all except the Sciarinæ live in fungi. Some (Sciphila) live outside fungus growths and form a webbing.

The adults are true flies (Diptera) which have an elongate and compressed body, small head, and are usually dull-coloured. Numbers of species occur in Britain. Mushroom beds can only be kept free by frequent removal of soil and occasional fumigation. [F. V. T.]

Mycorhiza are forms of roots modified by an invasion of the root tissues by fungus filaments, whose action is not destructive but helpful, in that they assist in nourishing the plant. The roots of some trees, such as Oak, Beech, Poplar, Elm, also Pine, Spruce, and other Coniferæ, are of two kinds: (*a*) normal roots with root hairs; (*b*) mycorhiza, or short, knotted, 'coral-like' roots covered externally with a coating of fungus filaments which suppress the formation of root hairs (see fig.). Mycorhiza occur in humus soils, and as the fungus has greater power than the root hairs for attacking organic remains, they prepare available plant food and pass it into the roots. In other forms of mycorhiza, the fungus filaments occur chiefly inside the root cells; this is the case with a number of humus-loving plants of moorlands and woods, such as heather and other Ericaceæ, also some pines and moorland grasses. Orchids appear to be dependent on the co-operation of mycorhiza fungi, and the successful germination of seeds requires the presence of a suitable fungus. The root tubercles of Leguminosæ and Alder may be regarded as mycorhiza in which symbiotic bacteria live in the tubercles and supply the plants with ready prepared nitrogenous material (see BACTERIA). [W. G. S.]



Tip of a Rod of Beech with closely adherent Mycelial Mantle (× 100)

Myelophilus minor is a small Scolytid beetle about $\frac{1}{8}$ in. long, very similar to the Pine Beetle. It is told from it by the bristle-bearing tubercles being continued on the second interstice of the elytra up to its base, as on the other interstices. The beetle's flight time is April and May. It chiefly attacks Scots Pine and Spruce. It may be found on trees up to fifty years old. The beetles select the upper portion of the trees, where the bark is thinner. The larvæ hatch in June, and pupate in July in a chamber made in the sapwood. The beetles emerge in July and August, and generally pair in the following year. Those which appear early may produce a second brood. The mother galleries are large, regular, double armed, and horizontal, with a rather long entrance burrow, and are deep in the sapwood. So serious is the damage that trees are speedily killed by it, or become stag-headed. The larval galleries are short, and not numerous. This insect burrows deep into pine wood. Like the Pine Beetle, it also bores into the pith of young pine shoots. It is found in the Dee district of Scotland and many other places in company with the Pine Beetle, with which it is confused.

Protection the same as for the following, but the trap trees must have smooth, thin bark (see next art.). [F. V. T.]

Myelophilus piniperda (the Pine Bark Beetle), a most destructive pest of Scots Pine, Weymouth and Cluster pines and others, occasionally of the Spruce and Larch. Old and young trees are attacked alike, but it seldom occurs in woods less than ten years old. The beetle is about ⅙ in. long, with black head and thorax, dark-brown elytra, and rusty-red antennæ and tarsi; the wing cases have fine punctured striæ, the interstices being granulate, each with bristles, which are absent on the apical portion of the second interstice. The flight time of the beetle is at the end of March, in April and May, and again in June and July. The females lay as many as 120 eggs, in preference on the southwest side of the trees. There is no breeding chamber, for copulation takes place outside on the trees. The females attack for preference old trees that are diseased or dying, and felled timber, and trees damaged by wind, snow, and lightning. Young trees are attacked when no old ones occur. First of all, then, bark miners, both as adults and larvæ, attack the bark and bast. The beetles make longitudinal galleries with one to three air holes. The entrance hole is usually under a bark scale, and may be detected by ejected wood or by a drop of turpentine. The larvæ eat out secondary galleries in the bast, which are more or less at right angles to the primary gallery, eventually becoming more or less merged. Unlike the parent gallery, they only touch the sapwood and do not cut deep into it. When mature, the maggots pupate near the bark, and the beetles emerge from it, leaving behind numerous flight holes. This damage done to the bark is not all, for a most serious attack is made on the young shoots. The newly hatched beetles of the broods in August and September bore into the pith of young pine shoots at a distance of 1 to 3 in. from their extremities, choosing especially sickly and old trees near the borders of woods, where they eat out a tunnel a couple or more inches long towards the bud. The entrance hole is marked by a ring of resin, and either from this or a new hole the beetle escapes and attacks another shoot. The weak shoots break off and fall to the ground. Strong shoots from the crown develop the suppressed buds between the pairs of needles, and these may grow out and give a characteristic bushy appearance. Owing to the loss of bored shoots, the crowns of trees acquire a characteristic appearance which may readily be recognized; they assume the form of a cypress instead of the usual dome-like shape, a few side branches spread out prominently on each side. Still, in another way the beetle does damage by boring down for two or more inches to the sapwood of the rootstock of sound trees in order to hibernate. In consequence, trees become unhealthy, and may even die.

Protective and Remedial Measures.—All dead and sickly stock must be speedily removed, and all stumps uprooted. Trap trees may be formed and felled from February to September, so as to keep up a supply of trees not too dry for the beetles to breed in. Some trees should be barked in May, and others at intervals of four to six weeks, and the bark burned in pits. [F. V. T.]

Myosotis is the botanical term for a genus of plants belonging to the class Dicotyledon, and to the nat. ord. Boraginaceæ. The various species are commonly called Forget-me-not and Scorpion Grass. The plants are small hairy herbs, with stalked entire ground leaves and alternate sessile entire stem leaves. The small flowers are stalked and arranged along the upper side of an axis that is curled round like a crozier (*scorpioid cyme*, or *cincinnus*) and destitute of bracts. The blue rose, or white corolla, is composed of a short tube and a five-cleft limb. At the junction of tube and limb, five special outgrowths (*ligules*) occur, which together constitute the yellow eye of the corolla. When the plant is in fruit, the corolla and stamens have fallen away; but the calyx still persists, and holds within it four small, smooth, glossy nutlets, each composed of a shell (seedcase or pericarp) containing a seed. In marshes, ditches, and bogs, grows the true Forget-me-not (*Myosotis palustris*); in shade, the Wood Forget-me-not; and in fields, the annual Field Forget-me-not (*Myosotis arvensis*).

Among seeds of Italian Rye Grass small, dark, glossy impurities are occasionally found. These are the nutlets of Myosotis. [A. N. M'A.]

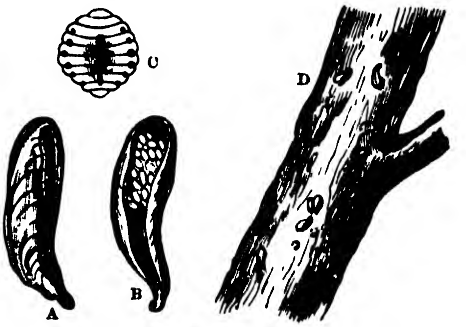
Myriapoda, a group of the arthropods which includes millipedes and centipedes. In external form they are wormlike, but in internal structure they are allied to the insects. The body consists of a large number of similar segments, each of which possesses paired limbs. As centipedes are carnivorous and poisonous, and in the main beneficial to the agriculturists, it is important to distinguish them from the injurious millipedes, which are non-poisonous, and exclusively vegetarian in their habits. The body of the centipede is usually flat, while that of the millipede is cylindrical; the centipede has one pair of limbs to each segment, but the millipede has two pairs (except on the first three segments); the antennæ of the centipede are many-jointed, while those of the millipede have only seven joints; the genital aperture in the centipede is on the second last segment, in millipedes the two genital apertures open anteriorly. The mouth parts of the millipede are adapted for chewing, there being powerful mandibles wherewith to devour the roots of plants and other vegetable matter. Centipedes are very active in habit, and are provided with poison claws to kill their prey. The life-history of the millipede is similar to that of the centipede. The female deposits her eggs in a round nest made of pieces of earth, and having a hole at the top through which the eggs are dropped. The eggs mature in about a fortnight, at the end of which time the young millipede, with only three pairs of legs, emerges. Subsequent growth takes place by the addition of new segments posteriorly. Several ecdyses or moults take place before sexual maturity is reached. Perhaps the most troublesome millipede is *Iulus pulchellus*, which is about ⅓ in. long, pale-yellow in colour, and has a double row of crimson or purple spots on it. This species is specially destructive to roots of all kinds, and is reported as being very harmful to lily bulbs and potatoes. *Iulus terrestris* is an-

other common millipede, recognized by its black colour and pointed tail. Another species, *Iulus londinensis*, has a round tail. Various methods of destroying these millipedes have been suggested by the Board of Agriculture (Leaflet 94). In the field, broadcasting with lime and working it into the soil is recommended. In the garden the application of soot and water (a handful of soot to half a gallon of water) to the roots of plants drives them away for a time. To trap them, scooped-out pieces of mangolds, placed just under the ground near the plants attacked, attract swarms of these pests, which may then be destroyed. They may also be trapped by placing pieces of cabbage leaves soaked in Paris green about the garden; the millipedes feed on this and are poisoned. The life-history of the centipedes is described in the arts. GEOPHILUS LONGICORNIS and LITHOBIUS FORFICATUS. [R. H. L.]

Myrtle.—The Common Myrtle (*Myrtus communis*, nat. ord. Myrtaceæ), an evergreen shrub with white flowers, a native of South Europe, and of very old introduction, is only hardy in the warmer parts of the kingdom, but it is so attractive as to be worthy of wall cultivation or a place in the greenhouse elsewhere. Of the numerous other species, *M. Ugni*, a native of Chile, which bears red or black edible fruits, is the most noteworthy. Myrtles are of easy cultivation, and are best suited by a sandy loam. They require an abundance of water in the summer. Propagation is usually effected by cuttings of half-ripened wood inserted in a close frame. Myrtles are agreeable pot plants for greenhouse or room decoration. The Greeks regarded them as the symbols of youth and beauty, and the leaves contain a volatile oil which used to be esteemed medicinally. The flowers of Myrtle are used for bridal wreaths in Germany. [W. W.]

Mytilaspis pomorum (the Mussel Scale).—The Mussel Scale insect is one of the Coccidæ, and is one of the worst insect pests the fruit grower has to contend with. It is essentially an apple pest, but it also occurs on pears, plums, currants, &c., in this country. The distribution of this Coccid is very wide; in fact, we may say it occurs in all the countries in which apples are grown. This wide range is accounted for by its easy distribution on nursery stock from country to country. The popular name of Mussel Scale is derived from the general resemblance it has to the mollusc of that name. The trees are mainly attacked on the trunk and twigs in this country, but now and again the fruit and the leaves are invaded. Abroad this is more usual. The insects are then distributed on the fruit as well as on young trees. Abroad it also infests butternuts, Ailanthus, Sassafras, Syringa, Cytisus, &c. The damage they do is caused by sucking away the sap with their long proboscides, and by so thickly encrusting the trunks and twigs that they block up the lenticels or breathing pores. In young stock the damage is most important. Old trees can withstand the attack to some extent.

LIFE-HISTORY, HABITS, AND STRUCTURE.—The 'scale' covering the actual insect varies in size and shape, between ⅛ and ⅙ in. in length. In form the 'scale' is swollen and rounded at one end, more or less bluntly pointed at the other, flattened in form, and the lower surface closely applied to the tree. A faint white membrane is seen around the edge, and at the narrow end is a small, paler area, the cast skins of the larval insect (called exuviæ). On lifting up one of these scales in winter and looking at it with a magnifying glass, we shall find beneath a mass of white powder. This on examination will be found to be a mass of eggs of oval form. In June these dustlike eggs give rise to active six-legged larvæ, which soon escape from beneath the scales, and a little later are recognized as small white specks on the bark. If the larva is destined to become a female it never moves again after once fixing upon its abode. By degrees a waxy secretion is passed out by its skin, and the rudiments of the scale commence to form. Then the larva casts its skin, and this fuses with the waxy



Apple Mussel Scale (*Mytilaspis pomorum*)
A, Female mussel scale, dorsal view. B, Ventral view. C, Larva. D, Branch infested with mussel scale.

covering and forms the smaller area mentioned above in the old scale. Gradually the larva loses its legs, antennæ, bristles, and the mature female form is attained. This female is found under the scale as a footless, fleshy mass. She then deposits her eggs and dies. The male Mussel Scale insect is winged, and escapes from beneath a smaller and differently formed scale. The end of the male's body is prolonged into a process for fertilizing the female. Males are very uncommon in this scale insect. During the changes between the larva and mature male a kind of pupal stage takes place (pro-pupa).

The distribution is carried out locally by various insects which carry the larval scales, and by birds which fly amongst scale-infested trees.

The natural enemies in this country are of no help, although some laboratory workers maintain that Chalcid parasites keep it in check. Scales parasitized by these minute hymenoptera show a small round hole by which the adult has escaped from the scaly covering of the insect which it has destroyed in its larval stage.

Treatment.—Nursery stock should always be fumigated with hydrocyanic acid gas before being planted. Trees badly attacked should be sprayed in winter with paraffin and caustic wash, composed of 6 per cent paraffin, 5 per cent soft soap, and 3 per cent carbonate of soda. In June, when the young scale insects are mov-

ing, the trees may be sprayed with dilute paraffin emulsion; the paraffin being not more than 3 gal. per 100 of water, and about 5 lb. of soft soap. The latter is only recommended in bad attacks, as paraffin is always harmful to foliage. [F. V. T.]

Myzus cerasi (the Black Fly of the Cherry).—Every fruit grower and gardener knows the 'black fly' of the cherry, and the amount of damage it may do to the crop. This damage is especially noticeable on wall fruit, where the cherries frequently become covered with a black gummy mass—the honey-dew, and black excrement and fungus growth which collects upon the honey-dew. The tips of the shoots become smothered with the Black Aphis, and in young sweet cherries and old Morellos actually kill the shoot. In large trees the pest is not so serious, as they are better able to withstand the attack. The attack usually commences in the beginning of July to be noticeable, but in reality it begins at the end of May, upon the lower leaves as a rule. It may continue until the beginning of October.

The aphis in its wingless viviparous form is black and shiny, with some ochreous areas on the legs. Winged females are produced from the colonies, and these fly off and produce other living young; they are wholly black, but sometimes the abdomen is clouded with dull green. Previous to the winged adult a pupal stage is formed, of a deep olive-green hue, shiny, and with pale wing cases.

The young coming from wingless and winged females are at first pale-dusky, and gradually assume the shiny coal-black hue.

In autumn, egg-producing females and males occur. The male is dusky-black, with dull ochreous spots on the abdomen, and five brown transverse bands and four spots on each side. The oviparous or sexual female is shiny-brown. These may occur as late as the end of October on the cherry trees. The autumn females lay shiny-black eggs on the trees especially low down, and these remain there till next April or May; the aphis first appearing on the lowest leaves on nursery stock. It has also been recorded as feeding on Plum and Black Currant, but probably these have been accidental occurrences.

Treatment.—The only thing necessary is spraying with soft soap and quassia wash, as much as one can of the latter, as it has a most cleansing effect upon the fruit and leaves. It is advisable to use this wash on the first signs of attack, as after the leaves at the tips of the shoots begin to curl, the wash loses much of its power. The Black Fly stick very hard on the shoots and leaves, and plain water to knock them off, as once suggested, is mere waste of time. Soft soap will kill them, and the quassia cleans the foliage and fruit. [F. V. T.]

Myzus persicæ (the Nectarine and Peach Aphis).—This is the common aphis of peaches and nectarines. The apterous viviparous female is rosy to rusty red; the pupa has three greenish stripes down the dorsum; wing cases yellow tinged with green, and two red spots on the occiput. The winged viviparous female is very varied—some almost black, others brown and black, some more or less orange or red with brownish markings.

The winged forms may occur in May, and continue on and off right through the year. In October, 1870, Buckton records them as appearing in immense numbers on the peach trees at Clifton. The winged male is bright citron-yellow, with brown markings on thorax and abdomen, dark at the extremities, but in the other stages pale-green. The beautiful pink colour of the aphis is mainly caused by highly refractive globules of pink oil in various parts of the body.

Treatment should only consist of spraying with soft soap and quassia; paraffin emulsion is too strong for such delicate-leaved fruit trees. [F. V. T.]

Myzus ribis (the Currant Aphis).—This currant aphis causes the leaves to curl up, and is especially found clustering on the top of the shoots, which become contorted and stunted. This aphis occurs from April to August, especially on Black Currants and Gooseberries, but now and then on Red Currants. The apterous female appears from the eggs in spring; she is shiny yellowish-green, with dark-green mottlings, elongated oval in form, and with curious capitate hairs in front; cornicles and legs pale-green; eyes red. The larvæ or lice are pale-green. The pupæ shiny yellowish-green, with two spots on the head. The winged viviparous female is bright-green, with pale-olive head, brown thorax with an olive band across the front; the abdomen has irregular transverse bands and spots, dark cornicles, and olive-green tarsi; eyes red. The oviparous females, which occur in autumn, lay longish brown eggs under the exfoliated rind of the shoots, where they remain until next spring.

Treatment is the same as for the former species, but it is still more important to spray early, as they soon cause the leaves to curl; and as they also check the growth of the shoot, a dense tuft of curled leaves is produced, against which no washing will do any good. [F. V. T.]

N

Nagana.—This disease is caused by a trypanosoma (*T. Brucei*) which is transmitted by the Tsetse fly, and is distributed widely over Uganda and the Soudan. It affects horses, asses, mules, cattle, goats, pigs, dogs, and some wild species, as antelopes and hyænas. The Zulu word 'nagana', according to Bruce, signifies a sinking condition, which is one of the chief symptoms. It is invariably fatal to horses, asses, and dogs, but a few cases among cattle have been known to recover. [H. L.]

Naked Barley. See art. BARLEY.

Naked Oat. See art. OAT.

Narcissus, Daffodil, &c., a genus of ornamental bulbous plants (nat. ord. Amaryllideæ), natives of Europe, North Africa, and North and West Asia, with flowers, solitary or umbellate, drooping or inclined, white or yellow, leaves linear or strap-shaped. Nearly all of them are hardy, but some kinds—those from Spain and the Mediterranean—flower early in the winter, and are not well adapted for growing out-of-doors in this country. Narcissi are the best of all spring flowers. The number of beautiful hybrid varieties is now legion, and it is continually being added to. Great advances have been made of late years in the production of pure-white and orange-red varieties of the Daffodil section of the genus. There are six species of Narcissus and their hybrid progeny which are perfectly adapted for outdoor cultivation in gardens. These are: *N. Pseudo-Narcissus* (Common Daffodil), *N. poeticus* (Pheasant's Eye), *N. Tazetta* (Polyanthus Narcissus), *N. Jonquilla* (Jonquil), *N. triandrus* (Angels' Tears), and *N. Bulbocodium* (Hoop Petticoat Daffodil); and by crossing these many valuable hybrids and seedlings have been obtained. Narcissi will thrive in almost any soil and situation with very little care, but the favourite garden sorts are best suited by good, deep, loamy soils with good cultivation; they are averse to fresh manure. Wherever possible the bulbs should be left undisturbed for several years; but an occasional lifting and separation of the clumps in June or July is advantageous, and it is best to lift and replant the more delicate varieties in fresh soil every year. The bulbs are planted from 3 in. to 7 in. deep, and for bedding effect from 3 in. to 6 in. apart, according to the habit of the variety. Narcissi are propagated by taking off the side bulbs at lifting time, and new varieties are obtained by cross-fertilizing, and sowing the resulting seed. Beautiful effects are obtained by planting Narcissi in the grass, in which position even delicate kinds will generally increase naturally. This kind of planting must be done in irregular fashion, and the foliage must not be mown down while green. Narcissi may also be planted in the mixed border and among shrubs. They are very well adapted for forcing, being either planted closely in boxes to provide cut flowers, or grown in pots for house decoration. By potting up the bulbs in August, *N. Tazetta* ('Paper White') may be had in flower before Christmas; and where greenhouse accommodation permits, there should be a succession of Narcissi from thence onwards until the outdoor flowers appear. The bulbs may be grown in water like hyacinths, or in bowls containing water and small stones. The older varieties may be purchased very cheaply in quantity, and for ordinary purposes are quite as good as the newer and expensive kinds. [W. W.]

Narcissus Fly, a fly somewhat resembling a bee in appearance, whose larvæ work havoc among Narcissus bulbs. See MERODON.

Nardus stricta (Moor Mat Grass) is a worthless perennial grass common on poor high-lying pastures, on moors, and along the dry margins of bogs. The plant is composed of a dense tuft of leafy shoots which are only 3 or 4 in. high. The leaf-blades are reduced to bristles so tough and wiry, that no animal except the goat will browse them. The slender wiry straw is sometimes no higher than the leaves, and rarely higher than 1 ft. The ear is a spike 2 to 4 in. long, with the purple spikelets confined to one side of the axis. The spikelet of Nardus is of the simplest construction—a single flower enclosed within a husk of two pales, the outer of which is awned. No other grass has a spikelet so simple as this. [A. N. M'A.]

Nasturtium, a genus of herbs belonging to the nat. ord. Cruciferæ. The principal species is *N. officinale* (the Common Water Cress), a native perennial aquatic or semi-aquatic plant very common in the northern hemisphere. The tender leafy shoots are much esteemed as a salad, especially during hot weather, and for this purpose the plant is cultivated in some of the eastern and southern counties of England, in low-lying or irrigated fields. There are several varieties of the plant known, those commonly cultivated being the Green-leaved or Summer Cress, suitable for still waters, and the Brown-leaved or Winter Cress, which succeeds best in running water. Water Cress will grow on a damp or shady border in a garden either from cuttings, which may be obtained from wild plants, or by sowing seeds, which are sold by many seedsmen.

Nasturtium amphibium, known as Water Radish, and *N. sylvestre* or Water Rocket, are both natives of Britain, but are of no economic importance. The so-called Nasturtium or Indian Cress of our flower gardens belongs to the genus Tropæolum. See TROPÆOLUM. [A. H.]

Natal, Agriculture of. See SOUTH AFRICA, AGRICULTURE OF.

Natural Grasses.—This term is applied to any grasses, other than those intentionally sown, which spring up in meadows and pastures. The origin of these naturals is either from seeds in the land, or from pieces of underground creeping grasses which serve as propagative organs. Some tell us, for example, that on poor light soils Perennial Rye Grass changes its nature and becomes Sheep's Fescue or Hard Fescue. The explanation of this apparently miraculous occurrence is quite simple—the Rye Grass dies out, and seeds of Hard Fescue, previously in the land, germinate; the result is a crop of Hard Fescue with nothing to hide it, the sown grass having died out. A similar case is the replacement of Rye Grass by Yorkshire Fog (*Holcus lanatus*). The latter grass is ripe before the Rye Grass, and when the hay is being cut, much seed of Yorkshire Fog is shed over the land. In a year or two, there is abundant herbage of Yorkshire Fog and but little of Rye Grass, for, as the residual Rye Grass dies out, the Yorkshire Fog springs up from its own seeds and takes possession of the unoccupied surface. Sweet Vernal is another natural grass which is one of the earliest to mature and sow its seeds. Its seeds soon germinate, and a cover of Sweet Vernal forms over the surface left bare as the Rye Grass dies out. Of all natural grasses originating

from seed, Yorkshire Fog and Sweet Vernal are the most common; and it is worth noting that both are true perennials, which stock browse only with the greatest reluctance. Accordingly, the seedmaking process goes on unimpeded; any land left bare by dying Rye Grass is soon seeded and taken possession of by these weeds. If plots of similar land side by side are seeded with Rye Grasses and with Cocksfoot respectively, within a few years the Rye Grass plots are found to be overrun by Yorkshire Fog and Sweet Vernal, whereas the Cocksfoot plots show hardly a trace of these grasses. Such experiments show conclusively that by judicious seeding of pastures, the natural grasses cease to be natural, and that the sown grasses come to the front. On certain soils the predominant natural grass is the useful sole grass, Crested Dog's-tail (*Cynosurus cristatus*). This predominance is explained by the circumstance that Crested Dog's-tail, unless eaten down when young, is allowed to mature and sow its seeds unchecked; the dead Rye Grass leaves plenty of room for the development of these Dog's-tail seeds into plants.

We consider now the creeping grasses, pieces of which left in the land can propagate and soon overrun unoccupied surface. The commonest of these creeping natural grasses is Bent or White Grass (*Agrostis vulgaris*), which creeps underground or along the surface at its own convenience. Another is the surface-creeping Rough-stalked Meadow Grass, and still another is Smooth-stalked Meadow Grass, which creeps only in the depths of the soil. All these creeping grasses are perennials with small leaves, that is sole grasses, and to keep them in check, the land should be made as clean as possible before seeding. Care should also be taken that any dung applied is 'clean', and free from living pieces of these weeds. Above all, large-leaved, truly perennial grasses, such as Cocksfoot, should be well represented in the sow-out, for, though the small creeping natural grasses spring up, they are kept in check by the shade from the large-leaved grasses.

The question for the agriculturist is, are the natural grasses better than those sown, and if not, can sown grasses oust the naturals? Of course the natural grasses are got cheap and with minimum trouble; indeed, the easiest and quickest way to get them is to sow the hayloft sweepings, composed mainly of Yorkshire Fog and Goosegrass (*Bromus mollis*). But the question is, are these naturals as valuable as grasses that can be sown? The almost unanimous answer is no. The name 'natural grass' is apt to mislead; after all, it is but a high-sounding name for weeds and for inferior grasses, which, though sometimes useful, must not be allowed to predominate in our pastures. [A. N. M'A.]

Natural Regeneration of Woods. See SYLVICULTURE.

Navel Ill.—Navel ill is an infective disease brought about by the invasion of septic organisms similar to, if not identical with, those inducing joint ill. The organisms gain access during the period when the navel cord is moist; the natural withering which usually takes place in a few days affords subsequent protection. The inflammation which commences in the umbilical vein soon spreads to the adjacent tissues, and suppuration follows, perhaps blood poisoning as well. From the suppurating matter in the vein a discharge is set up which, escaping from the body, stains the skin around the tumefaction. Once infected, the umbilical cord remains moist when it should have dried up, and a hard mass extrudes with a taplike appearance. A probe may be introduced into the vein, as it remains patent. Too often the first symptoms are not observed. They consist in loss of spirits and a disposition to stand and arch the back more or less; the teat is not sought, and an increasing indifference to surroundings presently ends in the young animal persistently remaining on the ground, stretched out and somnolent. If the lungs are affected, the respiration is hurried. The temperature rises from the first, and fever continues; the eyes are dull, and the membranes when examined will be found injected; the pulse quick, and small in volume; mouth hot and dry; and constipation of the bowels is commonly followed by scouring or diarrhœa, the urine being high-coloured, and small in amount.

Treatment.—If discovered sufficiently early, an injection of a suitable antiseptic is recommended, such as a 2-per-cent chinosol lotion, or 1 in 1500 of perchloride of mercury, finding the orifice of the vein and inserting the nozzle of the syringe in it, but not too forcibly sending the medicament into it. If the stage of suppuration has been reached, the swelling should be boldly lanced, the parts fomented, and carbolized oil applied on a four-ply lint pad, retaining it in position by a surcingle, or band passing over the back and attached to the neck and under the tail. If by frequent antiseptic dressings the pus is brought out and blood poisoning averted, the animal has a fair chance of recovery. We would earnestly impress upon stock-breeders the importance of prevention by the simple means of tying the umbilical cord as soon as possible after the foal or calf is born, and the application of antiseptic dressings. Those which rapidly evaporate are to be preferred, as favouring the withering process. Salicylate collodion is perhaps the best of all, but rather expensive where large numbers are concerned. [H. L.]

Navicular Bone. See COMPARATIVE ANATOMY; FOOT.

Navicular Disease.—This serious form of lameness in horses may come on suddenly after severe work, or so insidiously that the horse-owner with difficulty realizes the malady. Often indeed the owner attributes the symptoms to stiffness, to fatigue, or to a rheumatism. There are no external signs whereby it may be diagnosed, and all sorts of feet are subject to it. As a rule, the earliest symptom is a disposition to point alternate front feet, or one foot persistently, bringing forward the opposite diagonal to relieve the fore part of weight. This may occur and even endure for some time before the short or 'groggy' step is noticed on coming out of the stable. Even then it is usual for the subject to warm up and throw off the lameness after a variable amount of exercise,

and to carry his owner as well as before. As the disease progresses, the symptoms are aggravated, the pointing being more consistent, and the stiffness and short gait more pronounced and lasting. Examined after death, the lesions in a number of subjects will be found to vary considerably, some showing ulceration of the cartilage of the navicular bone, others an inflamed area, and still others no bone changes at all, but all the signs of chronic inflammation of the contiguous structures. This lameness is often attributed to the shoulder, and called 'shoulder-tied'.

Treatment is rarely satisfactory, as the blister and the run at grass are deceptive. The animal returns apparently sound, but quickly falls lame again when put to work. A Charlier shoe is beneficial if paring out has caused contraction of the heels. A long rest on a wet piece of pasture favours expansion, and a few cases of arthritis recover; but where the navicular bone itself is diseased, nothing answers but division of the nerves, whereby feeling is cut off and the animal does not go lame, although the destructive work continues in the foot. See NEURECTOMY. [H. L.]

Necrosis.—The meaning of this word has expanded in the hands of modern pathologists, and may be taken to imply the death of any tissue, whether hard or soft, belonging to the organs, or the skeleton, or the common integument. There are many cases as well as causes of necrosis in animals, some of them originally due to violence and others to disease. *Treatment* is only practicable where we can reach the seat of trouble and remove the necrosed tissue by the knife and forceps, or facilitate its solution and outward passage by destructive agents or the enlargement of the wound. This method of treatment is dealt with in connection with the various forms of fistula. In some necroses of the organs a drying process or an enveloping capsule follows if the subject of it regains its health, but a fatal termination is almost invariable. [H. L.]

Nectarine.—The nectarine is a variety of the peach *Prunus* (*Amygdalus*) *persica*, the peach having downy fruits and the nectarine smooth fruits. True nectarines have been raised from peach stones, and there have been numerous cases of peaches and nectarines being produced on the same tree. In all characters except that of the skin of their fruits, peaches and nectarines are exactly alike. For their cultivation nectarines require the same treatment as peaches (which see). They are grafted on seedling peaches, plums, or almonds; they are also known to come fairly true from seeds. The best varieties in the order of their ripening are: Early Rivers, Lord Napier, Dryden, Rivers' Early Orange, Violette Hâtive, Stanwick Elruge, Humboldt, Pine Apple, and Victoria. [W. W.]

Negligence, as a legal term, consists in the failure to perform a duty due to others, and where damage is directly caused through such failure, a right of action emerges to the party damnified. Negligence may occur in a great variety of circumstances, but consideration of the subject is here confined to negligence in the use of property.

The owner of a property, though entitled in theory to deal with it as he chooses, is nevertheless limited in his use by certain obligations and restrictions, conceived in the interests of his neighbours and based on the maxim that every man must so use his own property as not to damage his neighbour's rights.

Damage caused to a proprietor through the negligent use of his property by a neighbouring proprietor may arise (1) through the natural use of the land, or (2) through what is termed the non-natural use.

First, as to damage arising through the natural use of the land. In such cases specific negligence must be averred and proved, otherwise no action for damage will lie. Such a case might arise through fire; and if negligence were clearly proved on the part of the owner on whose property the fire originated, he would be responsible for the loss caused to his neighbour, but not otherwise.

The question has been raised whether if a man leave his field uncultivated and it consequently becomes covered with thistles, whose seeds are blown on to his neighbour's lands, where they take root, he could be held liable to his neighbour in damages. In England the point has been decided that as thistles are a natural growth of the soil, the man who allows them to flourish on his own land does not thereby wrong his neighbour, and consequently cannot be held liable to him in damages.

Second, as to damages arising from the non-natural use of land. The import of the term 'non-natural use' is that the proprietor has done something on his property which is in its nature liable to cause damage to his neighbour, and which is not necessary in the ordinary management of his property. In such cases specific negligence does not require to be proved, or rather negligence is still the ground of action, but it will be more readily inferred from the mere fact of damage having been sustained, for one who puts his property to a non-natural use is bound to observe a higher degree of diligence to prevent injury to his neighbour. On this principle reparation has been found due to a farmer whose farm was damaged and great discomfort caused to himself and to his family through the ignition of a heap of mineral refuse on neighbouring ground.

Operations which would at common law fall under the definition of non-natural use of the ground, may by force of statutory authority become natural or usual incidents of the operations authorized. Consequently in the case of injuries to property caused by companies or public bodies acting under statutory authority, and within the scope of that authority, there is no claim for reparation unless negligence be proved. Such cases have frequently arisen through damage caused by railway companies in the conduct of their business, *e.g.* damage by fire caused through sparks from engines.

For the statutory modification of this rule introduced by the Railway Fires Act of 1905, see under FIRE—RAILWAY FIRES ACT.

But, apart from injury caused to adjoining property, action may arise through the dangerous condition of a man's own property. If the owner of a property, expressly or impliedly, invites persons to come on to it, he is bound to see that it is so kept as not to be likely to cause injury to anyone lawfully entering thereon. Thus where a gasfitter, who was sent to do certain work in the defendant's premises, fell into an unfenced hole of which he had no warning, it was held that the owner of the premises had failed in the duty he owed to strangers who were lawfully on the premises. But this will only apply to persons lawfully on the premises, and a mere trespasser has not as a general rule any claim for damages. In the same way, tradesmen or others making use of a road as an access to a house to which they are going on lawful business, are entitled to expect that they will be protected from any unexpected danger.

The defences open to the owner from whose ground the source of damage has emanated are, in the case of non-natural use of the ground, three, viz.: (1) *Vis major* or the act of God; (2) the wrongful act of a third party; or (3) the default of the complainer.

1. With regard to the first plea, the act of God has been defined as 'an accident, which can be shown to be due to natural causes directly, and exclusively, without human intervention, and which could not have been prevented by any amount of foresight, pains and care reasonably to be expected'; but as the effect of admitting this plea would be to encourage carelessness, or at all events might tend to paralyse foresight, the Court will not willingly admit it, especially in cases where the proprietor has put his ground to a non-natural use.

2. As to the second plea, the wrongful act of a third party, the owner may escape responsibility for the act of a servant, for whom he has ordinarily responsibility, if he has not ordered or authorized the thing to be done, and more especially if he has forbidden it. Where, however, something is done which is in the common line of a servant's duty, no special instructions having been given, the master is liable for the servant's act, and so long as the servant is acting within the general scope of his employment, a prohibition as to the manner or place of doing an act within that employment does not relieve the master from liability for the servant's negligence. As a rule a master is not liable for the illegal act of his servant, and therefore is not liable for any crime or fraud committed by him, unless the master knowingly benefits thereby. But where a servant, acting within the scope of his employment, commits a crime, *e.g.* assaults someone, the master would be held liable.

3. Where the plaintiff has, by his own negligence, directly contributed to the damage, he will, as a rule, be barred from claiming damage.

A proprietor is as a rule not 'bound to wait till a threatened or impending mischief shall be done, but is entitled to protection where there is reasonable fear of injury'. Consequently, in addition to his right to reparation for damage, if and when done, he is also entitled to anticipate the damage if there be clear proof of imminent danger, and to prevent the possibility of loss by obtaining the authority of the Court to restrain the proposed operations. [D. B.]

Negundo.—*Acer Negundo*, the Box Elder (nat. ord. Sapindaceæ), is a hardy tree attaining to 30 to 40 ft. in height. It differs from the true maples in having pinnate ashlike leaves. The varieties with silver and golden variegated leaves are more extensively grown than the type, being as good variegated trees as any that we have. The variety *californicum* is an extra strong-growing kind. This tree grows well on chalk. The variegated varieties are usually propagated by grafting, or by budding in summer. [W. W.]

Nematodes, or Threadworms, comprise many parasites injurious to man and domesticated animals, and some which attack plants. Some are as much as 17 in. in length, while others may not exceed $\frac{1}{30}$ in. In animals they generally infest the stomach and intestines, but some attack the lungs and breathing passages, the muscles, or the blood. The following groups are recognized:—

1. *Palisade Worms* (Strongylidæ).—Many worms of this group infest the intestines and the breathing organs of domesticated animals and fowls, generally causing colic and loss of condition, or such well-known diseases as 'husk' in lambs or 'gapes' in chickens. See arts. HOOSE; GAPES.

2. *Whip Worms* (Trichotrachelidæ).—The best-known example is the *Trichina*, which infests the muscles of pigs and can be communicated to man. See arts. MEASLES; TRICHINA.

3. *Slender Threadworms* (Filariidæ).—These are very small worms which generally infest the blood system or the connective tissue.

4. *Round Worms* (Ascaridæ).—These are comparatively large and thick worms which infest the intestines of domestic animals. See ASCARIS.

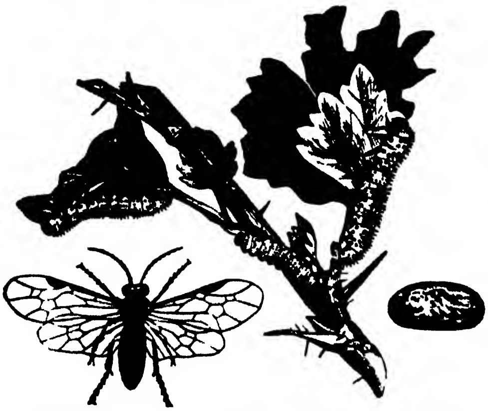
5. *Eelworms* (Anguillulidæ).

It is important to note that in many cases these parasites are acquired by animals from foul water, access to which should be prevented where possible.

For an account of the Stem Eelworm see TYLENCHUS. For the Root-knot Eelworm see HETERODERA. [C. W.]

Nematus ribesii (the Gooseberry and Currant Sawfly) lays its eggs in the leaves in April or May, and the resulting 'caterpillars' feed rapidly, often entirely stripping the bush of its leaves. When young they are dull-green with a yellow ring behind the head and another near the tail, but when older they are uniformly green with black spots. They must not be confounded with the true caterpillars of the 'Magpie' moth, which attack the same plants. These are 'loopers', and brightly marked with orange, yellow, and black. When the sawfly caterpillars have finished feeding, they go down just below the surface of the earth to pupate, or they take advantage of any rubbish or litter of dead leaves at hand for that purpose, and here they remain till the following spring, so that after the attack has been mitigated as far as possible by hand-picking or spraying, its recurrence the following year may be entirely prevented by

appropriate treatment of the soil beneath the bushes. The surface earth may be removed and



Nematus ribesii Male Sawfly, caterpillars, and cocoon, all much magnified

buried deeply, or a dressing of gas lime may be applied. [C. W.]

Nephritis, inflammation of the kidneys. See KIDNEY, DISEASES OF.

Nerium, a small genus of very ornamental but poisonous greenhouse shrubs, natives of the Mediterranean region and subtropical Asia. The species of most importance is *N. Oleander* (the Common Oleander), the many fine varieties of which are so popular upon the Continent, and might with advantage be far more generally grown under glass, and in tubs placed out-of-doors in summertime in this country in place of the more sombre Bay and Cypress. The flowers are borne on the mature shoots, and the wood requires to be well ripened by full exposure to sunshine. During the season of growth the plants need plenty of water, but after flowering this should be withheld for a time. Neriums may be propagated by cuttings placed in a warm frame, or rooted in bottles of water. They are very subject to insect pests, and require to be frequently washed. [W. W.]

Nervous Diseases. The various affections of the nervous system are described in separate articles. See arts. MENINGITIS; MEGRIMS; CHOREA; STRINGHALT; APOPLEXY; PARALYSIS.

Nervous System. For a description of the nervous system, see the article PHYSIOLOGY OF FARM ANIMALS.

Nettle, or **Stinging Nettle** (Urtica), is a member of a large order of dicotyledonous plants called Urticaceæ. The plants are erect herbs with opposite leaves and covered with stinging hairs; the small green flowers are without petals and of two sorts—the males with stamens only and four sepals, the females with pistil only and two sepals. The sting of the Nettle when examined under the microscope is found to be a single cell with a glassy wall shaped like a flask and drawn out into a long sharp point. The sap in this cell is very acrid. When the hand touches the Nettle, the fine sharp point of the flask enters the skin and breaks. This breakage irritates the protoplasm within, and causes it to contract so as to inject the acrid sap into the wound. If the Nettle is grasped by the hand, the acrid fluid is poured out into the thick skin which covers the grasping part of the hand, and so no pain is felt. Two species of Nettle occur as weeds on rich land:—

1. LESSER STINGING NETTLE, OR SMALL NETTLE (*Urtica urens*), is a small annual weed rarely above a foot high, with egg-shaped, deeply toothed leaves, and oblong or globular clusters of flowers much shorter than the leaf-stalks. To eradicate, prevent seeding.

2. GREATER STINGING NETTLE, OR COMMON NETTLE (*Urtica dioica*), is an underground creeping perennial which every year produces erect stems about 2 ft. high. The leaf is heart-shaped, with coarse teeth along the margin, and a long point at the apex. The stem contains fibres which have been used for making cordage, fishing lines, coarse cloth, &c. Being an underground creeping plant, eradication is difficult: bodily removal of the underground parts and repeated cutting of the young shoots are aids to extermination. [A. N. M'A.]

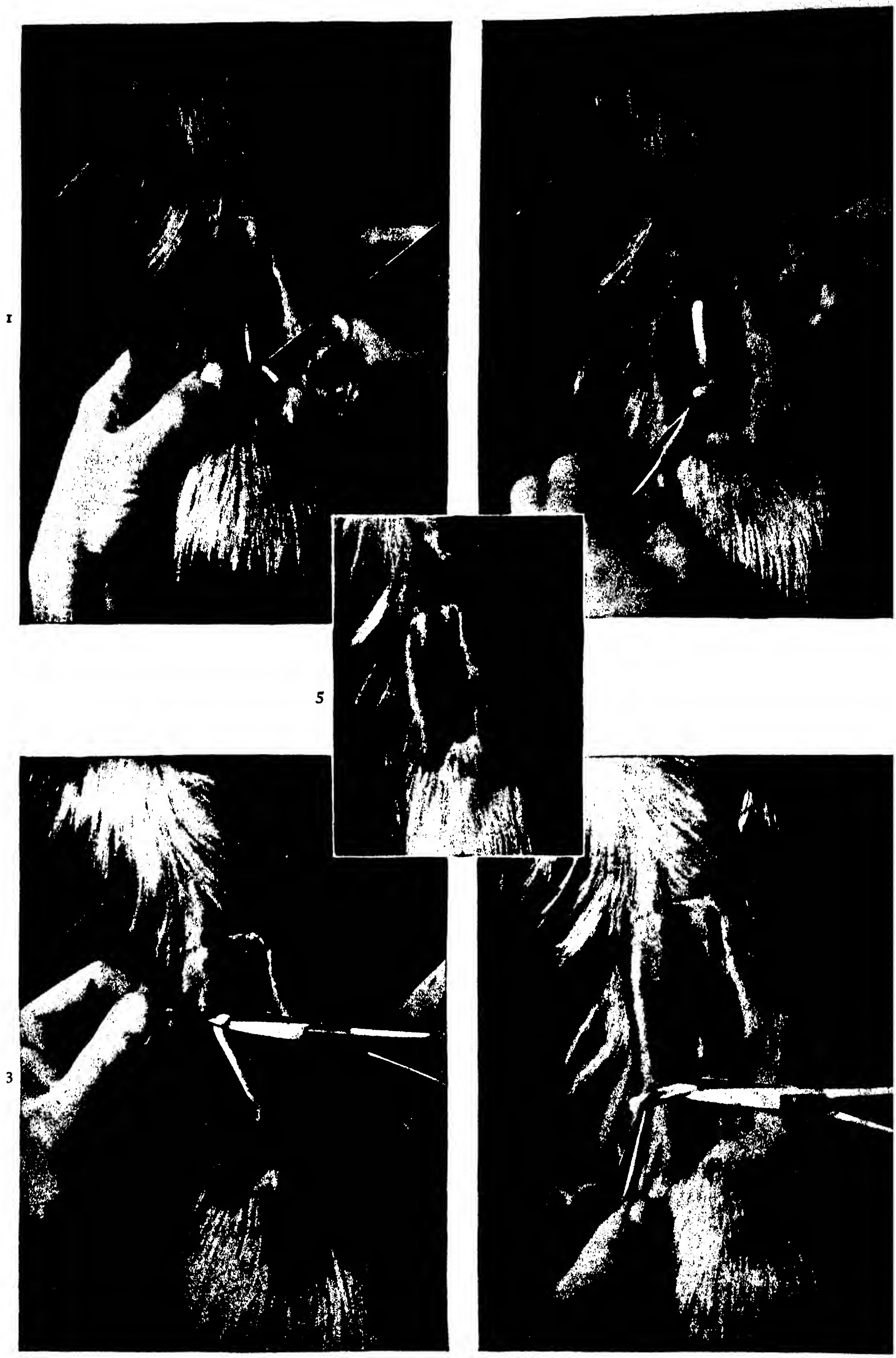
Nettle Rash.—The suddenness of the swellings, and the similarity they bear to lumps produced by stings, accounts for the name, and distinguishes it from other affections. After the first feed of grass, or a deep draught of cold water given to the animal when heated, or following upon sudden change of diet, this rash is seen upon horses along the neck, sides, and croup. It often disappears in the course of a few hours, or may persist long enough to require treatment. Digestive disturbance is the cause, and an ounce of bicarbonate of soda, or twice the quantity of bicarbonate of potash, may be given in solution, and repeated next day, when it will probably pass away. Outward applications are not desirable, but clothing should be put on. It takes a different and more alarming character in cattle: the eyes, ears, neck, and base of the tail swelling severely, and the skin of the body feels both thick and hard. The practice of bleeding is quite unnecessary, and the barbarous custom of cutting the septum of the nose is to be condemned *in toto*. Half a gill of turpentine in a pint of linseed oil will effect a cure in most cases, and benefit appears to follow on a few ounce doses of hyposulphite of soda. [H. L.]

Neufchatel Cheese is not only covered with mould on the crust, but, like the Stilton, it has mould within. It is a product of new milk renneted from 60° to 62° F., in vessels which hold about 20 qt. The curd is brought in forty-five minutes, after being stirred in the milk at 86° F. At the end of twelve hours it is placed with great care in a cheese cloth, fastened by the corners to a wooden vessel somewhat resembling a rectangular washing tub. Here it parts with the larger portion of its whey. Thereafter it is placed in a clean cloth within a frame of slatted wood, but without top or bottom, or in a box in which the wood is pierced with many holes. A board with a weight to press out the whey is placed upon the top of the cloth in which the curd is held. After the

lapse of twelve hours more, the curd is again placed in a clean cloth and mixed with the hand, that the cream may be properly distributed, and the drier curd mixed with that which is most moist. The consistence of the curd must be exact throughout; if it is too dry a small quantity of wetter curd is added; if it is too wet it may be subjected to further pressure until the exact condition has been reached. The curd, now termed *pâte*, is ready for the moulds —small cylinders about 5½ cm. in diameter by 6½ cm. in length. When these moulds are filled the cheese is salted at the ends, the quantity of salt employed being about 17 oz. per hundred cheeses in summer, and slightly more in the winter season, or, in other words, the quantity of salt required is from 3 to 4 grm. per cheese when the whole is salted. The cheeses still in the moulds are left to drain for twenty-four hours in the drying room, where they are placed upon clean, dry straw, remaining, after removal from the moulds, for from two to three weeks, being daily turned either on their side or on one end. At the end of five weeks they will usually be covered with a white fungus, which gradually changes to blue. When they are completely covered with the blue mould they are taken to the ripening room and again placed on straw, which should be carefully drawn for the purpose and preferably made into mats. Here they are turned twice a week until they are ripe for market, when they weigh about 4 oz. each. A gallon of average milk produces 21 oz. of cheese, the price realized being in accordance with their condition, whether they are sold as Bondons in the form of green curd, or fully ripe and blue within; in this condition they realize in the retail market about 3*d.* each. [J. Lo.]

Neurectomy, or **Neurotomy.**—This operation, the division of sensory nerves in order to deprive some portion of an animal of feeling, is performed where the disease is known to be incurable, and some useful service may yet be obtained from the subject without cruelty. The nerves operated upon are not of the kind which control nutrition; otherwise their division would result in death or necrosis of the parts previously innervated. Notwithstanding this, it sometimes does happen within a comparatively short time that a member—a foot, for instance—will decay and separate from the living tissues innervated by other trunks or branches; and this sequel to unnerving is so generally known that the non-professional mind finds it difficult to believe that the divided nerve was not at least a mixed one; nor is there any satisfactory explanation forthcoming why an unnerved leg should undergo a gelatinoid degeneration if blistered. Confining our observations for the present to unnerved feet, we may say that quite the majority of cases prove successful; that not only does the patient do some years of useful service, but no sooner is the subject of a comparatively low weak foot operated upon, than he commences to grow a good strong one, than which no better proof could be offered of the nutrient nerves performing their office. In cases of navicular disease (which see), of sidebone and ringbone of an incurable character, division of some nerve of supply may be taken advantage of, to deprive the painful area of sensation. For navicular lameness one or both branches of nerve running over the pastern bone may be divided; but the most experienced operators usually deem it necessary to perform on the main trunks (plantar nerves) on either side of the limb, and about 2 in. above the fetlock. If both of these trunks are cut, there remains scarcely any sensation in the whole foot save for a small area in front of the coronet, where a few filaments of nerve are derived from another source. Ringbones and sidebones will be relieved by the same operation, which is still called the 'high' one, to distinguish it from a similar performance on branches of the same trunk which pass down the sides of the suffraginis bone. The high operation is not the highest now performed, and further confusion is introduced in the student's mind by the nomenclature which dubs the division of the nerve trunk under the armpit the 'median'. It is, of course, a nerve called the median, and the trunk of the tree from which the lower branches already referred to are derived. This great trunk is divided when seeking to relieve lameness at the knee or between it and the fetlock. Those divisions of nerve already mentioned are largely successful—a remark which scarcely applies to operations upon the hind limb for the removal of hock lamenesses. The operator must be a good anatomist and skilled surgeon. The patient is cast, chloroformed, and secured; the parts shaved, and dressed with antiseptics; the skin divided; the nerve separated from connective tissue, and when 'clean', cut through; the distal end or portion (now having no sensation) is pulled and stretched in order to excise a variable amount—a precaution against reunion and the restoration of the current. When this takes place, by the formation of a lozenge-shaped growth, the lameness returns, and operative interference is again called for. [H. L.]

New Forest Ponies.—The New Forest ponies, of which there are authentic records since the time of Canute, were originally larger than they are at present; indeed, they have decreased in size even within the memory of the present generation. Nowadays real Forest ponies, able to live all the year on the open Forest without any hand-feeding, rarely exceed 13 hands high; many are much smaller. A pony of 12·3 hands is a big one. They are of all colours, though duns are exceptional. It would be idle to suppose that the ponies on the Forest are of any pure type. Up till 1888 no provision was made (as far as is known) since the time of Henry VIII for a supply of stallions of any type or uniformity of size. If an entire pony happened to be too bad to sell, or his owner too busy to see him, he was too often left to propagate his species with his sisters and his cousins and his aunts, who in their turn were bred in the same way. Thus it may well be imagined that a very rapid deterioration was taking place, and unless the regulations made in 1888 had been enforced the



NEURECTOMY: THE HIGH PLANTAR OPERATION

1. Making the Incision. 2. Needle passed below the lateral digital nerve and threaded with carbolized silk or gut.

breed must have disappeared. At that time, however, an association was started with the consent and assistance of the Verderers of the New Forest. No stallion over two years was allowed to roam in the Forest unless passed by the Verderers and their veterinary surgeon, while premiums were given to induce commoners to keep their best stallion colts. Many experiments have been tried with Thoroughbreds, Hackneys, Arabs, and other crosses, but it is now pretty well established that a very small percentage of these are successful, as few of their stock can survive at all under natural conditions. The introduction, however, of other mountain and moorland blood has been eminently successful, especially with the Fell, West Highland, and Exmoor ponies. The great drawback at present to the advancement of the New Forest pony is the want of gates on the Forest roads. By prescriptive right the commoners could insist on these being kept in repair and working order, as their absence or neglect means a very serious loss, especially as nearly all of those possessing ponies are of the labouring class, who can ill afford such losses, as the fines for ponies found straying are very heavy and make this branch of agricultural industry very hard to keep up.

In appearance the New Forest pony of the present day is somewhat common, and the hardship of its life does not improve its appearance. If, however, a pony with a small head and good shoulders is selected, taken care of, and judiciously fed, it generally turns out untiring either to ride or drive, and an extremely willing and powerful carter. It is no uncommon sight to see a man of 10 or 11 stone catch up a pony and ride most of the day after other wild ones; while they might form an almost ideal stock for rapid army transport. [A. C.]

Newfoundland Dog.—The intelligence of the Newfoundland is very high, and as a consequence he can readily be taught to retrieve objects both on land and in water. He is moreover a capital companion, but in the case of some dogs there is a natural infirmity of temper which renders it necessary that they should be kept well under control and not teased in any way. The head of the Newfoundland is large and broad, the skull being flat on the top and the occipital protuberance rather strongly developed, whilst the muzzle is of fair length and should be of considerable substance. The eyes are a little on the small side and dark in colour; a yellow eye detracts entirely from the benevolent expression this dog should possess, and is therefore a bad fault. The ears, which are covered with soft, velvety hair, are small and lie close to the sides of the head. The neck is very powerful, the shoulders sloping, and the chest both wide and deep so as to allow plenty of room for the heart and lungs, for the dog's work in water involves a considerable strain upon these organs. The front legs should be of a fair length, straight, very heavy in bone and muscular, whilst the feet ought to be extremely large. The body is rather long, with a muscular back and powerful loins, and the hind quarters and limbs should also possess plenty of strength, the tail being long and carried in a slight curve, but not over the back. The correct shade of coat in the breed is a rusty black, the redness being probably due to the fact that the original island breed passed a great deal of their time in the sea and the salt water affected the blackness of their hair. Both jet black and rusty black are consequently perfectly legitimate colours, and so too is the golden

Newfoundland Dog

liver which occasionally appears as a 'sport' in connection with these shades, as it does in the case of retrievers. As may be imagined the condition of coat is an important point in the case of a dog which passes so much of his time in the water, and consequently the outer jacket should be profuse, rather harsh in texture, and lie flat without any curl about it, whilst the under coat must be close and like sealskin so as to prevent the water from penetrating to the skin. The average weight of the breed is from 90 lb. to 100 lb. [V. S.]

New Zealand, Agriculture of.—Farming and grazing in New Zealand are conducted under conditions which, in the main, closely resemble those of the United Kingdom, the variations being in favour of the colony. The crops, pastures, live stock, and systems of cultivation are the same as may be seen in the Old Country, save that it is not necessary to house cattle, and some of the machinery and implements used are more advanced; and an English, Scottish, or Irish farmer has little difficulty in adapting himself and his methods to the colonial conditions.

Climate.—The climate is in the highest degree salubrious. The country extends from the 34th

to the 47th degrees of south latitude, and thus a gradation of climate from subtropical in the north to temperate in the southern parts is enjoyed. The temperature is for the most part equable; changes are sudden and frequent, but the thermometric range is not great, the summer heat not being excessive nor the winter cold intense. The rainfall may be described as regular, excessive precipitation on the one hand and prolonged absence of rain on the other being seldom experienced. The winters are short, the utmost duration of the period during which grass ceases to grow being about three months, while in favourable seasons, except in the extreme south, grass, roots, and grain crops grow without interruption. Snow, except on the mountain tops, seldom is heavy or remains long on the ground. Abundant sunshine is enjoyed, not only in the summer, but also in the winter, it being computed that the total annual duration of sunshine is 20 per cent longer in New Zealand than in England.

According to information published in the Statistical Abstract for the Colonial Possessions of the United Kingdom, based on four years' observations, the highest mean shade temperature for the colony was 78° F. and the lowest 33° F. The North Island had in 1905 a mean temperature of 55·9°, and a total rainfall of 49·34 in., on 168 days; the South Island had a mean temperature of 51·9°, with a rainfall of 47·91 in., on 161·5 days.

In almost all parts there is an abundant, pure, and permanent water supply from streams and rivers; and the few tracts of land which are not thus favoured can be supplied by artificial streams brought from the upper waters of the rivers. On the Canterbury Plains, many thousands of miles of these channels—locally termed 'water-races'—have been constructed; they have been provided exclusively for the purpose of supplying drinking water for live stock, and have had the effect of enabling the large areas in which the land was formerly held in order to secure a river frontage, to be divided into smaller holdings fully stocked with sheep and susceptible of intense cultivation. In many extensive areas artesian water can be obtained at no great depth, of unequalled purity and very low temperature—generally 55° to 56°.

Soil.—The area of the Dominion is 104,751 sq. miles, or 67,040,640 ac., of which 28,000,000 ac. are agricultural land, and 27,200,000 ac. pastoral land. The area in occupation in October, 1906, was 37,408,473 ac., of which 14,486,426 were in cultivation. Of the latter area nearly 89 per cent was under artificial (sown) grasses (34 per cent on arable and 55 per cent on unploughed land), nearly 5 per cent in roots and green crops, and rather more than 6 per cent in grain and pulse (of which a considerable area was grown to be fed off by stock). The uncultivated occupied area and a large extent of country still unoccupied consist of land in native grasses or bush, capable of carrying large flocks of sheep and herds of cattle, and much of it fit for cultivation when cleared.

The soil generally is of great natural fertility. Even the apparently barren lands have been proved capable of growing certain grasses; also fruit trees, including the vine; and large areas have been planted with native and introduced timber trees which are making good progress.

The North Island is hilly and in parts mountainous in character, but with large plains and numerous valleys of rich land suitable for agriculture, the area of agricultural land in this island being estimated at 13,000,000 ac. The area of purely pastoral land is estimated at 14,200,000 ac. A large quantity of both classes of land is still in the native bush or swamp state, but clearing and draining are rapidly progressing. Grazing of sheep and cattle is the principal branch of agriculture practised. Almost all valuable grasses and most of the forage plants grow luxuriantly, the former being mostly sown on the surface after bush or fern had been cleared —generally by burning, the bush being first felled and allowed to dry. Dairying is an important and growing industry, the improved pastures providing abundance of grazing. Cereals produce heavy yields on some of the arable farms, but speaking generally the North Island soil is not suited for grain-growing.

The South Island is intersected from north to south, along almost its entire length, by the range of mountains known as the Southern Alps, from which minor ranges branch, merging by fertile downs into the valleys and plains. The mountains throughout the island are to a considerable altitude well grassed, and afford grazing for large flocks of sheep; the downs and lower hills are rapidly being brought into cultivation, chiefly for the production of roots and forage crops for sheep; and the valleys and plains are occupied by arable farms. The west coast of the island consists largely of native forest, but extensive agricultural areas are being developed. The land in the South Island is estimated to comprise 15,000,000 ac. available for agriculture, 13,000,000 ac. suitable for pastoral purposes, and 9,000,000 ac. of barren land and mountain tops.

Throughout the country the fertility of the lighter soils has been increased in a remarkable degree by cultivation and grazing by stock. Areas of land which under former systems carried only one sheep to the acre have been by good cultivation and judicious cropping rendered capable of carrying five sheep per acre.

The character of the soil is of extreme variety. There are large areas of volcanic soils, wide plains of mineral origin, extensive alluvial flats, many swamps, and a rapidly increasing quantity of cleared bush land in which vegetable matter predominates. The formation of most of the farming land is either a thin layer of soil on a shingle subsoil, or a deeper layer on a stiff clay.

The predominant characteristics of the several districts are, briefly, as follows:—

Auckland extends northwards from 39° S., and is subtropical, with vegetation of corresponding nature. Subtropical fruits, such as the orange, lemon, lime, olive, and grape vine, and plants such as tobacco, sorghum, hemp, and ramie or rhea, flourish with but ordinary care; while apples, pears, and hardy fruits generally, grasses, clovers, maize, potatoes, swedes, and

most other forage crops the cultivation of which is generally regarded as adapted only to the temperate zone, are grown with great success. The dairy industry, as is natural under such conditions, is of great importance and rapidly extending, even into the far north. The grazing of sheep and beef cattle, the production of fruit, and the conservation and milling into fibre of the New Zealand hemp (*Phormium tenax*) are also important industries.

Hawke's Bay, to the south of Auckland, on the east coast, is mainly pastoral, its pastures of native grass and those in which the indigenous grasses have been supplemented by surface-sowing with imported varieties providing most excellent grazing for sheep and cattle. Dairying is practised in suitable districts. Large areas are excellently suited for arable farming.

Taranaki, on the west coast, and *Wellington*, which comprises the whole of the southern part of the North Island, are almost entirely devoted to grazing. Most of the pastures have been surface-sown with imported grasses, and carry a large head of stock. Roots and forage plants yield prolific crops. Dairy-farming is the chief industry, but the higher country and lighter lands are devoted to sheep. Large areas are occupied by hemp.

Nelson, *Marlborough*, and *Canterbury*, in the South Island, are in the main similar in character, consisting chiefly of plains and rolling downs of light soil, and smaller areas of heavy land. Sheep-farming is the predominant industry, cultivation being mainly conducted with a view to the provision of feed for rearing and fattening sheep and lambs for export in the frozen state. The proportion of land under cultivation is greater in Canterbury than in any of the other provinces. This province is the colony's wheatfield, the whole of the Canterbury Plain, extending 150 miles from north to south and about forty miles from the sea-coast to the foot of the hills which branch from the Southern Alps, being suitable for grain growing, and producing abundant yields. The growing of barley (for malting) and peas (for seed) are special industries of the Marlborough district.

The lowland parts of *Otago* (including the formerly separate province of Southland) are very fertile, and are, as a rule, highly developed in an agricultural sense. Sheep-farming and dairy-farming are the leading industries, and both are being steadily extended. Wheat is grown to a considerable extent in the north of the district, and oats are very largely cultivated in Southland, while barley of high quality is grown in part of the central area, where also all hardy fruits and even grapes are produced in the greatest profusion and of the choicest quality.

Systems of Farming.—The grazing of sheep and cattle on the native pastures was for a long period after the first settlement of the colony the principal rural industry. The grain-growing capabilities of large areas of land, chiefly in Canterbury and Otago, were soon discovered, and the production of wheat in Canterbury and North Otago, and oats throughout Canterbury and Otago and especially in Southland, attained considerable magnitude. The usual practice on the Canterbury Plains was simply to plough the native pasture, and grow grain, crop after crop, until the fertility of the soil became exhausted and the yield ceased to be remunerative. Then the land was sown with grasses, mainly rye, and when these in turn were exhausted by grazing with sheep, a return was made to wheat-growing. There were exceptions to this crude system of farming, many experienced farmers observing a due rotation of crops, and bringing their farms into a high state of cultivation and productiveness; in Otago, indeed, this was the rule from the first bringing of the land under the plough. The majority of the Otago settlers were men of previous experience in farming, while with many of the smaller Canterbury settlers such was not the case. In other parts of the colony, and in the higher parts of the two provinces named, grazing was the almost exclusive industry, the production of wool being the chief consideration, and cattle being kept on swamp and bush lands.

The establishment of the frozen-meat export trade in 1881 gradually brought about a marked transition in agriculture. The pastoral industry, which from the first settlement of the colony had been the chief source of wealth, became merged into the agricultural, wherever the nature of the land permitted. The arable areas were divided into farms, and the cultivation of roots and forage crops for fattening sheep and lambs largely superseded the production of grain for export. More care was given to the actual cultivation of the land and to the laying down of pastures, and the use of artificial fertilizers became universal. Sheep were grazed in flocks of smaller size, the number of flock-owners increasing from 9149 in 1886 (four years after the first exportation of frozen meat), to 19,977 in 1907, while during the same period the average number of sheep in a flock has decreased from 1659 to 1049. The total number of sheep in the colony has increased from 12,190,215 in 1881, when the first sheep for freezing were slaughtered, to 20,983,772 in 1907, notwithstanding that during that period 56,000,000 frozen carcasses of sheep and lambs have been exported, besides many millions which have been slaughtered for canning or other purposes, and a considerable number exported alive. In the year ending 30th June, 1907, there were exported 4,591,403 frozen sheep and lambs (1,910,144 sheep and 2,681,259 lambs), value £3,249,120.

Many sheep are fattened on native pastures or on grasses which have been sown on unploughed land, this being for the most part in the North Island; but the greater number of the sheep and practically the whole of the lambs are fattened on cultivated grasses and forage crops, and to supply this fodder and fatten the greatest possible number of lambs for export at from four to eight months old (according to the prevailing conditions of pastures, climate, and breed of sheep) is now the chief object of agriculture in New Zealand.

The soil and climate of the greater part of

the colony are in the highest degree favourable for sheep-farming, and the carrying capacity of the land has been greatly increased by the cultivation and manuring which have been applied in the raising of the root and forage crops which have been grown in rotation. In some districts the carrying capacity of the land has been increased fivefold, and it is almost everywhere capable of being further enlarged. Sheep need no protection from the elements; they are free from disease, and the average rate of increase by lambing for the whole colony ranges from 65 per cent on the high country to 110 per cent in farm flocks. In a good season under favourable conditions increases of 130 to 140 per cent, and even higher, are frequently obtained in small flocks. The high percentage of increase, together with the low cost of fattening, renders sheep-farming a very lucrative business. The wool also is an important factor. The average weight of the fleece (unwashed) may be taken at 6 lb. for Merino and 8 lb. for cross-bred sheep. Merino sheep constitute only about 12 per cent of the colony's flocks, but there is an infusion of Merino blood in most of the cross-bred sheep of the colony, though many are becoming closely graded to British breeds, or are crosses of these. The English and Border Leicesters are in highest favour in the South Island, and the Lincoln and the Romney Marsh in the North Island, the last-mentioned being also extensively used for bleak and exposed situations throughout the colony. The Southdown and the Shropshire are specially used everywhere but in the south of the South Island for the production of lambs for early fattening. A breed, named the Corriedale, has been established by several Canterbury breeders, working independently. It originated in a cross between the Lincoln and the Merino, followed by careful selection, but no further infusion of fresh blood. It unites wool and mutton qualities, and is superseding the Merino on many sheep runs on higher country.

All the leading British breeds have been introduced into the colony, and many of the pedigree flocks are of merit scarcely less than that of the Old Country flocks from which they are descended. Indeed, some breeds of sheep thrive in New Zealand in a manner which results in a degree of perfection seldom obtained in Home flocks. An important trade in pure-bred sheep for breeding purposes has been established with Australia and several parts of South America, the natural conditions under which New Zealand sheep are reared giving them a great advantage over artificially reared sheep when introduced into the flocks of countries where sheep are kept in the open.

The system of sheep-farming may be said to begin with the large flocks on the pastoral country, from which, as a general practice, the wether lambs are sold to agricultural farmers or graziers to be fattened, and the ewe lambs are kept on until the autumn of the following season, when the surplus is sold for breeding purposes, chiefly to holders of the better class of pastoral land or large agricultural farms. These in turn pass on the ewes as they become aged to the smaller farmers, who provide them with cultivated fodder and obtain from them one or two crops of lambs, and then fatten them for the butcher. The fat sheep and lambs are generally sold, either on the farm or in the public market, to exporters, although many large producers export the meat to the London market for sale there on their account. The freezing companies will undertake for owners the charge of sheep, lambs, and cattle from receipt at the freezing works until sale of the meat, wool, &c., in London (or elsewhere) and payment of proceeds, at a consolidated rate covering every charge; and there are also numerous firms and companies who will undertake the same services, paying the freezing companies for slaughtering, freezing, &c., and the shipping companies for carriage. All meat for export (and most of that for local consumption) is slaughtered under the inspection of veterinary surgeons holding the qualification of M.R.C.V.S., London, appointed by and under the control of the Government, and there is no authenticated case of any diseased meat having reached the market from New Zealand. The meat is graded by the freezing companies into various classes, according to quality and weight, and these grades are so well known and reliable that large transactions in meat of stated descriptions are concluded by cable, often for shipments to extend over a period of several months.

There are in the colony thirty-eight meat-freezing works, employing nearly 4000 hands, and having an output in 1906 valued at £4,000,000. Besides their primary occupation of meat slaughtering and freezing, there are conducted at most of the freezing works the industries of meat-canning, fellmongering, wool-scouring, tallow and oleo refining, sausage-casings preparation, glue and gelatine making, manure manufacture, and the cold storage of poultry and eggs.

The production of wheat has lately been little in excess of the requirements of the colony, and of oats is becoming similarly restricted. About 6,500,000 bus. of wheat and 15,000,000 bus. of oats are consumed or used for seed in the colony annually. The transition has effected a vast change in the system of farming. Regular rotations of crops are observed, varying according to the widely differing conditions of soil, climate, and situation. When grassland of light character is broken up, either a grain crop or a turnip crop is taken, followed by the alternative crop (grain after roots and roots after grain). If wheat is grown, a catch crop of oats or Cape barley is taken, this being followed by turnips or rape, and then another wheat crop is taken with which grasses are sown, the land remaining in grass for two or three years. On stronger lands two grain crops may be taken; then an autumn catch crop, fed off early in the spring and succeeded by rape or turnips; and these followed by two more crops of grain, with the second of which the land is laid down to grass. The root, rape, and catch crops must be liberally manured. Since the restriction of wheat-growing a usual rotation on sheep farms comprises wheat (after grass), turnips or rape, oats with seeds; or a four-course rotation of turnips, wheat, rape, oats with grass. In both

a catch crop is taken after the wheat. Beans, peas, and potatoes are frequently included in the rotation on good lands, either before or after the cereals.

The grasses sown consist mainly of Perennial and Italian Rye and clovers. Where the pastures are intended to be more permanent, Cocksfoot, Meadow Foxtail, Crested Dog's-tail, and Sheep's or Hard Fescue are sown in addition to the Rye Grass and clovers. Other mixtures are also sown according to local conditions.

In some circumstances grass is laid down without a cereal crop, in which case a small quantity of rape is generally sown on the grass. Rape is also sown in conjunction with tares, oats, or Italian Rye Grass for spring fodder for ewes with lambs, and for weaning lambs. Rape, in fact, is the staple fodder for the fattening of lambs. Thousand-headed Kale is coming into favour for the same purpose, being sown thickly and fed off in the same manner as rape; if not too severely grazed in the autumn it will provide a good early bite in the spring, when there is often a scarcity of fodder and a great demand upon it. Mangolds are grown to a small extent for in-lamb ewes and milking cows during the winter.

For the surface sowing of land that is unploughable, Cocksfoot is generally the main or only grass used, but the so-called Kentucky Blue Grass has proved valuable where there is a sufficient rainfall—say 40 in. per annum. Timothy also is useful in damp soils. Many of the native grasses are of great value, but they have been to a large extent destroyed by burning and rabbits, and they are being replaced, as far as possible, by the introduced grasses just mentioned.

In the North Island the production of cereals has never attained large dimensions, the conditions generally being in favour of grazing. In addition to possessing three-fourths of the cattle of the colony, the North Island has as many sheep as the South Island. Cultivation has consisted almost entirely of the growing of rape and turnips for sheep, and oats (for chaff) for horses.

Cattle for beef purposes are fattened upon the native and improved pastures; and dairy cattle are fed similarly, with the addition in some districts of roots and hay during the winter. A little maize is grown for ensilage, but this method of preserving fodder is in its infancy here. The maintenance of the stock of cattle is due to the profitable results of dairy farming during recent years; but the arduous nature of dairy work, with the uncertainty of the supply of labour, is causing many dairy farmers to transfer their energies to sheep-farming. On the other hand, the proved efficiency of certain milking machines is leading many graziers to establish milking herds.

The number of cattle in the colony on 31st October, 1906, was 1,851,750, of which 543,927 were dairy cows. The herds of beef cattle consist chiefly of pure Shorthorns, though there are herds of the Hereford and Aberdeen-Angus breeds. Red Polled, Devon, and Highland cattle have also been introduced. All the pure breeds have been intercrossed in order to suit the requirements of particular situations or to produce a desired description of stock. The dairy herds consist almost entirely of crosses from the Shorthorn and Ayrshire, frequently with an infusion of the Jersey or Holstein. The milking strains of the Shorthorn are being assiduously cultivated, and pedigree herds of Ayrshire, Jersey, Holstein, Kerry, and Dexter Kerry cattle are carefully maintained.

New Zealand cattle have a high level of healthiness, and those diseases which are most prevalent have become so chiefly from inexperience in management on the part of the farmers, and are being overcome by observance of the advice and instruction of the officers of the Veterinary Division of the Department of Agriculture.

The export of frozen beef for the year ending 30th June, 1907, was 336,180 cwt., value £399,180. For the same period there were exported 308,330 cwt. butter, value £1,522,113, and 168,913 cwt. cheese, value £449,676. There are in the colony 212 creameries (butter factories), with 494 branch skimming-stations; 109 cheese factories, 361 private dairies making butter, 42 private dairies making cheese, and 128 packing-houses for farm-made butter. (These figures relate to the export branch only of the industry.)

The co-operative system has been most generally adopted in the manufacture of butter and cheese, the creameries and factories being owned by the milk suppliers, and the proceeds of the butter and cheese made, less the cost of manufacture and incidental expenses, being divided amongst the suppliers according to the quantity of butter fat contained in the milk delivered by each to the factory. The great bulk of the butter is made in central factories fed by branch skimming-stations in the surrounding districts; by this means economy of production and uniformity of product are secured. The butter and cheese are either sold for the season at a fixed price, or consigned to the London or other market for sale, a minimum price in the latter case being frequently guaranteed by the consignee. The produce is graded, free of charge, by officers of the Dairy Division of the Department of Agriculture, according to a defined scale of points; butter or cheese scoring 88 points or upwards being first grade, under 88 points and not less than 80 points second grade, and under 80 points third grade. The maximum is 100 points. The system of Government grading has unquestionably had the greatest influence in placing New Zealand produce in its high position in the markets of the world. The Government dairy-produce graders' certificates are accepted in the British markets as final, as regards both quality and weight, and the largest contracts contain no further stipulation than that the produce shall receive a certain number of points or be of first grade. The Government experts give instruction to butter and cheese makers and farmers on all matters connected with the industry. Many of the butter factories run all the year round, and few have a close season exceeding three

months' duration. Cheesemaking is suspended during the winter months; but many factories have dual plants and make butter or cheese according to the demand of the market or the period of the year. The manufactures of Stilton cheese, condensed milk, and dried milk are carried on successfully on a progressing scale.

Pig-keeping is carried on systematically in conjunction with dairying. The number of pigs in the colony in October, 1906, was 242,273. The breed most generally kept is the Berkshire, but the Middle and Small White, the Tamworth, and the Large Black are also bred. The pure or grade Berkshire and crosses between the Tamworth and the Berkshire and Yorkshire are favoured for bacon purposes as fattening more rapidly and with a larger proportion of lean meat than either of the latter two pure breeds.

Horse-breeding.—Horses of all breeds are reared in every part of the colony, and when care is exercised in the breeding the stock is of good quality and substance. The heavy horses are almost entirely of the Clydesdale breed, with a few of the Shire and Suffolk breeds. These and the majority of the saddle and driving horses, including those of the American trotting strain, are bred by the farmers. Thoroughbred horses for racing purposes are chiefly bred in special studs. There is a considerable export trade with Australia in all kinds of horses, more particularly in Clydesdales for breeding purposes, and regular purchases are made of lighter descriptions for Indian army purposes. Frequent importations are made of stud horses of the highest quality of the various breeds, both by private individuals and by the Government. The horses imported by the latter are stationed at different parts of the colony for the use of farmers. The number of horses of all kinds in the colony in October, 1906, was 343,059 (including a few mules and asses).

Seed-growing.—Many farmers throughout the colony devote a part of their land to the growing of agricultural and garden seeds for export as well as for colonial sowing. Peas, particularly, are extensively grown in suitable districts for English and American seedsmen. The seed of the Cocksfoot Grass (*Dactylis glomerata*) is a special product of certain localities, chiefly hilly country, where the grass has taken possession of the land. The land is merely closed against stock for a few weeks before the seed ripens, and the crop is reaped, threshed, and winnowed on the place where it grew, the seed being afterwards machine-dressed in the seed warehouses. Rye grasses, fescues, clovers, tares, and many other seeds are largely produced on cultivated lands.

New Zealand Hemp (*Phormium tenax*).—This is a native product of great and increasing value. Hitherto the millers who have prepared the fibre have placed their mills in localities where the plant grew abundantly, but recently the profit which is to be derived from growing the plant as a perennial crop has induced many landholders to plant small areas, and there is every prospect that it will before long be extensively cultivated. A large quantity of the fibre is used in the colony for the manufacture of binding twine (for use with harvesting machines) and cordage generally, and fibre to the value of £850,000 was exported in 1906. Government officers give instruction in the cultivation of the plant and preparation of the fibre, and grade the latter according to quality for export. Linseed (flax) is grown to a very small extent, and purely for the seed, which is used in the preparation of food for stock. Ramie, or rhea, has been grown experimentally with complete success, but it is not likely to displace the New Zealand hemp as a fibre plant.

Fruit-growing.—As a branch of farming, fruit-growing has hitherto been neglected, most of the fruit of commerce being grown on holdings exclusively devoted to the purpose. The production is not nearly equal to the local demand, and the export trade which has been successfully initiated is checked for want of supplies. All fruits which can be grown in the temperate zone attain special perfection under cultivation in New Zealand, and the lucrative results are leading to a large extension of the area devoted to fruit-growing. The Government gives advice and instruction in the formation, stocking, and management of orchards, and in the canning and preserving of fruit; and has planted a considerable area in fruit trees, vines, &c., with the view of selling or leasing it to settlers in suitable-sized blocks when the trees come into bearing. This course has been followed successfully by some private owners of land. Cider and various kinds of wines are made, and find a demand exceeding the supply.

Minor Industries.—The keeping of poultry and bees is becoming general. There is a good market for the products, both in the colony and abroad. Government instruction and assistance are given in these industries also. Nurseries are numerous, but are unable to supply the requirements of the colony in fruit trees and some other staple lines. Market gardening is capable of great development; the growing of vegetables for the large towns has to a large extent been allowed to drift into the hands of Chinese, but a strong feeling in favour of European production has lately been awakened. English methods succeed in all parts of the colony.

Forests and Timber.—The forest area of the colony is about 20,000,000 ac., but a large proportion does not carry marketable timber. Some of the most valuable timbers will be exhausted in a few years; of some other descriptions the supply, at the present rate of consumption and without destruction by fire, &c., is sufficient for from fifty to one hundred years. The forests are under State control and the timber cutting is by licence, the fee varying according to the kind of timber. Timber is also sold by auction, at per 100 ft., and by appraisement. As the more accessible forests become exhausted the cost of timber is rapidly advancing, and afforestation has become a question of moment. Most of the native timber trees can be propagated, but they are slow of growth, and the chief hope for a future timber supply rests in exotic trees. The Government has established several nurseries for the propagation of both native

and introduced timber and shelter trees, and is planting large areas of pumice plains in the north and sandy and barren wastes throughout the colony. Many landowners have planted extensively, and as the value of these plantations, for shelter as well as for timber purposes, becomes apparent, others are following the example. Shelter is of very great importance in a country where there is so much wind as in New Zealand; it has been stated that in some good farming districts as much as one-third of the land could profitably be devoted to plantations—the return being in the increased productiveness of the land and the improved condition of the live stock.

Of native trees the most abundant and valuable are the Kauri, Totara, Kawaka (Cedar), Rimu (Red Pine), Kahikatea (White Pine), Matai (Black Pine), and the Birches. Several of the scarcer timbers are also of great value. Introduced trees are headed by Eucalypts of many varieties, *Pinus insignis*, Oak, Ash, Poplar, Willow, and in some situations Elm and Birch. Many varieties of pines and conifers are proving suitable for extensive planting.

Land Tenure.—Most of the agricultural land of the colony has passed into private ownership. Cultivation by the owners is the rule, tenancy being exceptional in the case of these lands; change of occupancy almost invariably means change of ownership.

The Crown lands that are at present available for selection and occupation amount to about 2,500,000 ac., and further areas are being made available as rapidly as they can be surveyed. They are practically divided into four classes: (1) Town and village lands, the freehold of which is sold by auction at upset prices of not less respectively than £20 and £3 per acre; (2) suburban lands, sold by auction at an upset price of not less than £2 per acre; (3) rural lands, disposed of at not less than £1 per acre for first-class and 5*s.* per acre for second-class lands, these lands being sold or leased by auction or on application; (4) pastoral lands—*i.e.* rural lands unsuitable for cultivation, mountainous, not immediately required for settlement—leased by auction as pastoral runs of various extent, as the nature of the country may require. Lands of special value may be sold or leased by auction at such prices as the Land Board of the district may determine. No rural section may be larger than 640 ac. of first-class land, or 2000 ac. of mixed qualification—not more than 640 ac. of the same being first-class. Landless persons may select up to the maximum; holders of land only to an extent which will not bring their aggregate holding over the maximum. Small grazing runs may not exceed—first-class, 5000 ac.; second-class, 20,000 ac. Pastoral runs are limited to areas of a carrying capacity of 20,000 sheep or 4000 cattle. No person can select more than one run.

Crown lands may be acquired as follows: (1) By auction, after survey, in which case one-fifth of the price is paid down at the time of sale, the balance within thirty days; (2) by application, after the lands have been notified as open for selection, in which case the applicant makes the declaration and deposit required by the particular system under which he wishes to select. If there is more than one application for the same land, the matter is determined by ballot. Under the optional system of selection, lands for selection are notified as open for application on and after a stated day, and, 'at the option of the applicant', may be obtained on any of the three following tenures: (*a*) cash (freehold); (*b*) occupation with right of purchase; (*c*) lease in perpetuity. Plans and description of lands open for sale or selection are distributed all over the colony. Under the Land for Settlements Acts large estates are purchased by the Government for the purpose of closer settlement. The law fixes the rent of all lands so acquired at 5 per cent on their capital value, with a rebate of not more than 10 per cent for payment within one month of the due date; directs that such capital value shall include the cost of acquisition, survey, roading, subdivision, and administration; and specifies that all lands acquired must be disposed of under lease-in-perpetuity, with the exception of the lands classed as pastoral, which must be offered as small grazing runs. Regulations are prescribed for the occupation, improvement, and cultivation of lands held under this system.

(Full details of the various systems of tenure, and particulars of land for sale or lease, are given in the Crown Lands Guide, which can be obtained from the High Commissioner for New Zealand, London; the Commissioner for Crown Lands, Wellington, New Zealand; or any Land Office in the colony.)

Agricultural Education.—The educational authorities have initiated a system of instruction in the primary schools in the elements of agricultural science, illustrated in many cases by cultural plots in the school grounds. The extension of the system in more advanced form to the secondary schools is being organized. Cadets are received at the Government experiment stations for instruction in practical operations. The Canterbury Agricultural College is an institution without superior in the education of youths in the knowledge of farming generally and of live stock particularly. [G. B.]

New Zealand Hemp.—New Zealand hemp or flax is the fibre obtained from the leaves of *Phormium tenax*, a plant found wild in New Zealand, Norfolk Island, and other parts of Australasia. The plant belongs to the nat. ord. Liliaceæ, and possesses sword-shaped leaves varying in length from 3 to 6 ft. or more, arranged in a distichous or two-rowed manner on a short stem and rootstock. It produces tall branched panicles of yellow flowers. Several varieties are known: some of them which grow in marshes or on alluvial soils near the sea attain a height of 14 or 15 ft. and yield a coarse kind of fibre, while others of smaller stature with finer fibre are found on drier and more elevated ground in the interior of the country.

New Zealand hemp is soft, almost white, with a silk-like sheen, and is used extensively in the manufacture of rope, twine, floor matting, and paper. When prepared by hand the bundles of lignified fibres may be separated into thin

strands fine enough to be woven into fine fabrics. A very large amount is obtained from wild plants, but it is now cultivated in many parts of New Zealand, and to a slight extent in the Azores and St. Helena, to which islands it has been introduced.

The New Zealand hemp plant thrives best, and gives the most satisfactory yield and quality of fibre, on rich well-drained alluvial soils. It may be raised from seed, but it is chiefly propagated by division of the rootstock, the 'root sets' being planted in March or April in rows 6 ft. apart, and 6 ft. asunder in the rows.

New Zealand Hemp (*Phormium tenax*)

1, Flower. 2, Leaf. 3, Segment of perianth. 4, Fruit

The first crop is ready when the plants are five to eight years old, after which time three or four well-developed outer leaves may be removed from each of them annually in December or January, care being taken to leave the young central part of the plants uninjured.

The leaves yield about 10 to 15 per cent of raw fibre, the higher proportion being obtained from cultivated plants. From 40 to 50 tons of leaves are usually cut from an acre of carefully cultivated plants. [J. P.]

Nightingale (*Daulias luscinia*). — This familiar migrant is fairly common in central and southern England from mid-April till mid-September, but is rare in Wales, and entirely absent from Ireland, Scotland, and the extreme south-west of England. The plumage is brown and reddish-brown above, and dull-white below. The leaf-nest is lined with horsehair and vegetable fibre, and built close to the ground in a hedge. There are five greenish-brown eggs. The food chiefly consists of insects (including caterpillars) and worms, to which elderberries and the like are at times added. Though of no great importance to agriculture, the nightingale must undoubtedly be reckoned among beneficial species. [J. R. A. D.]

Nightshade, or **Bittersweet.** — In autumn, one often sees in hedges clusters of small ½-in.-long scarlet berries, tempting to the eye, but which are poisonous, and the cause of frequent accidents to children. These are the berries of Woody Nightshade (*Solanum Dulcamara*), a member of the Potato family Solanaceæ. The plant is an underground creeping perennial, which forms air shoots, 4 to 6 ft. long, straggling and scrambling among bushes. The leaf-blades are stalked, entire on the margin, 1 to 3 in. long, and egg-shaped, often with an additional smaller lobe or segment on each side (*hastate*). The violet flowers, with yellow anthers opening by apical pores, are arranged in stalked drooping clusters on the sides of the stem, usually opposite to the leaves. An annual species of Nightshade is often met with in gardens. This Garden or Black Nightshade (*Solanum nigrum*) has erect stems 1 ft. or more in height, ovate wavy leaves, white flowers, and black berries. There is less narcotic poison in this species. For Deadly Nightshade see BELLADONNA. [A. N. M'A.]

Night-soil, human excrement liquid and solid, plus varying amounts of foreign matter, such as earth, ashes, sand, and paper. The variation in the composition of night-soil may be as follows:—

Nitrogen, ·35 to ·15 per cent;
Phosphoric acid, ·25 to ·01 per cent;
Potash, ·20 to ·02 per cent.

In dealing with its disposal, sanitary considerations invariably take first place.

The collection of the night-soil, the storage (even if only for a short time) without loss of useful and useless volatile matter, and therefore without smell; the transport without being a nuisance; the application to land so far away from human habitations as not to be obnoxious, are all points to be considered in dealing with its disposal and preservation.

The direct application to land with immediate ploughing-in is perhaps the simplest and the best where such can be carried out. If not, the excrement may be mixed with dry earth, sand, ashes, sulphate of iron, gypsum, superphosphate, kainite, lime, peat, and charcoal, to abate the smell and preserve the manure.

In the British Isles, however, the water-closet system has practically done away with the dry system—only, however, to initiate another problem: the disposal of sewage matter in a highly diluted state. See also arts. POUDRETTE and SEWAGE. [S. A. W.]

Nipplewort (*Lapsana communis*) is a common annual field and hedge weed belonging to the nat. ord. Compositæ, and to that section of the order which has all the flowers ligulate and the juice milky (Liguliforæ). The plant is erect, 1 or 2 ft. high, bearing on the lower part of its stem the lyrate leaves, with a large, coarsely toothed terminal lobe, and, higher up, the small narrow entire leaves. The flower-heads are

numerous, small ($\frac{1}{4}$ in.), erect and yellow, with slender stalks arranged in loose clusters. The fruit is destitute of the pappus calyx which characterizes the other Composites with milky juice. [A. N. M'A.]

Nitragin. — Under this name have been sold pure cultures of the various nodule-forming bacteria which inhabit the roots of leguminous plants. Following on Hellriegel's famous discovery, much discussion arose as to whether each species of leguminous plant had its own nitrogen-fixing bacteria, or whether the same bacteria were common to all. Nobbe, who investigated this question, came to the conclusion that though there is widely distributed in the soil an organism which will cause nodule formation on many legumes, yet this organism becomes modified when living in symbiosis with each species of leguminous plant, and that the best results in soil inoculation are got when each species is supplied with bacteria taken from the nodules of the same kind of plant. Accordingly he placed on the market commercial preparations of the various nodule-forming bacteria. The cultures, which were supplied in nutrient gelatine, were to be dissolved in a large proportion of water and either applied direct to the seed or sprinkled on soil to be subsequently spread over the land. A certain measure of success attends the application of the Nitragin organisms to soils deficient or altogether lacking in nitrogen-fixing bacteria; but in old-established countries where the soil has long been under cultivation, it cannot be said that Nitragin has proved a success. See also INOCULATION OF SOIL. [R. H. L.]

Nitrate of Lime is one of the two new nitrogenous manures (see LIME NITROGEN) which have lately come on the market as commercial products. In both cases the nitrogen is obtained direct from the atmosphere. The chemical change and technical processes involved in the manufacture of the two manures are, however, different, but they are similar in this respect, that both require a cheap supply of electric power. The manufacture of lime nitrogen is based upon the fact observed by Cavendish and Priestley, that nitrogen and oxygen combine together under the influence of an electric flame, producing gases which ultimately dissolve in water to form nitric acid. Before the successful production of lime nitrate, nitric acid, &c., from the atmosphere as articles of commerce, several attempts with the same object in view had been made.

The first attempt on a commercial scale was by Bradley and Lovejoy at Niagara, where complete electrical gear was installed. They used for burning the air an electric current with a potential of 10,000 volts, with electrodes made of platinum. The chemical changes involved were:—

1. $N + O = NO.$
2. $NO + O = NO_2.$
3. $NO_2 + H_2O = HNO_3 + HNO_2.$

By neutralizing the acid with soda, nitrate of soda was obtained. Great technical difficulties were experienced in the working of the process, and as they appeared to be insurmountable, the enterprise was finally abandoned as unprofitable. Since this attempt, Professor Berkeland of Christiania, in co-operation with Mr. Eyde, an electrical engineer, found that much larger quantities of energy in the electric arc are necessary than were used by Bradley and Lovejoy. Working on that assumption, they constructed electric furnaces to supply the most suitable electrical conditions for burning the air, and from these furnaces they are now turning out annually many thousands of tons of nitrate of lime.

The first experiment factory for the Birkeland and Eyde process was established at Frognerkilms in 1903; in October of that year it was removed to Ankerlökken, where more electric power was available. It was further removed to Vasmoen, near Arendal, and later to Notodden, where they have now a self-contained synthetical nitrate-producing factory. The total horse-power available at Notodden is 40,000, and with thirty-six furnaces. Extensive additions are, however, contemplated by utilizing the River Rjukan in Telemarken, where it is estimated that 220,000 horse-power will be available. The enterprise at Notodden is in every way a success, and forms one of the latest instances of how a scientific discovery can be utilized for establishing a technical industry of enormous commercial importance.

Nitrate of lime as supplied to the market is in the form of small hard crystalline lumps containing about 13 per cent of nitrogen. It is readily soluble in water. It has the disadvantage, however, of being very deliquescent, and when left exposed, absorbs moisture from air, becoming in course of time moist and sticky. It must therefore be stored in dry sheds, with the sack or cask mouth fastened. The nitrogen in lime nitrate is immediately available, and like nitrate of soda can be applied as top-dressings. A large number of experiments have been tried in Great Britain, Europe, and America to test the value of the nitrogen in this manure with that in the well-established nitrogenous manures, and everywhere the results have proved entirely satisfactory. On normal soils the nitrogen in lime nitrate is equal in its manurial effects to that of nitrate of soda. In soils deficient in lime salts it has proved superior to the latter manure. It should be purchased on the basis of the percentage of nitrogen present. An attempt was made to counteract the deliquescent nature of the manure by making a basic salt containing some quicklime. This form though hygroscopic did not become moist, and was from its powdery state more suitable than the lime nitrate for applying to the land. However, for some reason it is no longer manufactured. Improvements will no doubt in course of time be effected in the somewhat unfavourable mechanical condition in which lime nitrate is at present sold. [R. A. B.]

Nitrate of Potash, also known as potassium nitrate and popularly as nitre or saltpetre, KNO_3, is used to a limited extent as a manure. It is also used in the manufacture of explosives and fireworks, and for a variety of other purposes. It is found as an incrustation on the soil of certain hot countries, such as India

From such soils the main supplies of saltpetre were at one time obtained, and a considerable quantity is still derived from them. The saltpetre in these soils has been formed by the decay and nitrification of nitrogenous organic matter. The nitric acid formed then combines with potash to form nitrate of potash. Such soils must contain, therefore, natural supplies of potash. The nitrate of potash is dissolved out of the soil and purified by a process of crystallization. The crude nitrate obtained from the soil is very impure. Much saltpetre was also obtained formerly from artificial nitre beds. Such beds were at one time a very important source of the nitre used in making gunpowder. Nitre beds consisted of well-aerated beds of decaying organic matter such as horse dung. These were watered with urine to keep up the supply of nitrogen. Plant ashes were added from time to time to supply potash. In these beds decay and nitrification took place, and the nitric acid formed combined with potash from the plant ashes to form crude nitre. Nowadays nitrate of potash is obtained very largely from nitrate of soda or Chile saltpetre, and muriate of potash. When these are dissolved together in a boiling-hot solution, common salt crystallizes out, and when the solution is afterwards cooled down, nitrate of potash crystallizes out.

Nitrate of potash is a most powerful and active manure. It supplies the soil with both nitrogen and potash in the most active and easily assimilated forms. The pure salt contains 13·9 per cent of nitrogen and 46·5 per cent of potash. The crude salt, which is used for manurial purposes, contains a little common salt and other impurities, and the percentages of nitrogen and potash are therefore less than those stated above. The use of nitrate of potash as a manure is limited by its cost. As nitrate of potash is manufactured from nitrate of soda and muriate of potash, it is cheaper to buy nitrate and potash in these salts. Except then in certain particular cases where a little additional cost is of small consequence, such as for certain horticultural purposes, nitrate of potash is seldom used as a manure. [J. H.]

Nitrate of Soda. — Nitrate of soda (or 'Chile saltpetre') is a natural product occurring in certain regions of Chile. It is found in the form of saline deposits of varying thickness below the surface of the earth, in which deposits the nitrate is associated with various other salts, forming the material technically known as 'caliche'. Of the deposits of caliche which are actually worked, the rich qualities contain from 40 to 50 per cent of nitrate, medium qualities from 30 to 40 per cent, and the poorer qualities from 17 to 30 per cent. There are in addition large quantities of deposits containing proportions of nitrate below these limits. The principal salt associated with the nitrate in the caliche is sodium chloride, or common salt, but there are also present sodium, calcium and magnesium sulphates, varying quantities of potassium salts, and small quantities of various other salts, including compounds of iodine. The 'manufacture' of the nitrate of soda of commerce simply consists in the separation of the nitrate from its concomitant salts by processes of lixiviation, concentration, and recrystallization. The working details of the processes are of little importance to the agriculturist, who is only concerned with the final product.

The nitrate deposits occur in a tract of country which is practically rainless. Various theories have been formed as to their origin. That nitrate of soda, like Indian saltpetre, was originally formed by the nitrification of some organic substance, there seems to be little room for doubt. It has been suggested that these nitrate fields contain the oxidized drainage from former guano deposits. But the supposition which has received the most general support is that they have been formed by the gradual accumulation of the oxidized drainage from masses of decaying seaweed. Although the geological and climatic conditions under which their formation may have taken place seem likely to remain obscure, the seaweed theory of origin appears to derive strength from the constant presence of iodine compounds, which, although in small quantity, are sufficient to enable the manufacture of iodine to be carried on as a regular accompaniment of the refining or concentration of nitrate. It has, however, been pointed out that bromine is absent in caliche, whereas bromine as well as iodine might be expected if the seaweed theory be accepted. An alternative suggestion of origin is the gradual evaporation on the plains on which the deposits are found of the freshwater drainage flowing down from the mountain regions behind, charged, like all land drainage, with nitrates formed by the oxidation of the nitrogenous vegetable debris of vast tracts of surface soil.

Commercial nitrate of soda of good quality, as imported for agricultural purposes, contains from 95 to 96 per cent of actual nitrate of soda, the remaining 4 to 5 per cent consisting of moisture, sodium chloride, sodium and magnesium sulphates, and insoluble matter. Small quantities of sodium or potassium perchlorate are sometimes present, but in good nitrate the quantity is insignificant. In the nitrate made from some deposits the nitrate does not consist wholly of nitrate of soda, but includes a minor proportion of nitrate of potash. Good nitrate of soda of about 95 per cent purity contains about 15·6 per cent of nitrogen, equivalent to 19 per cent of ammonia.

The quantity of nitrate exported from Chile in 1908 was 1,733,540 tons. Out of this quantity about 1,272,000 tons were sent to the Continent of Europe, 308,800 tons to the United States, and 105,090 tons to the United Kingdom. These enormous quantities of nitrate are by no means wholly used for agricultural purposes. Nitrate of soda is one of the raw materials for the manufacture of sulphuric acid, and is used in very large quantities for making nitric acid for the manufacture of explosives. It is difficult to estimate the relative proportions used as manure and for such industrial purposes as those just mentioned; but the quantity consumed in the United Kingdom for purely agricultural purposes—that is to say, used directly as manure—has been roughly estimated at 43,000 or 44,000

tons per annum. It is difficult to estimate the life of the nitrate fields, but the most recent survey, carried out by Señor Alejandro Bertrand on behalf of the Chilian Government, appeared to indicate that sufficient caliche is 'in sight' to represent some 220 millions of tons of nitrate. This would suffice to maintain the present output for more than a century, without taking into account the probable existence of further beds in the unexplored portions of what may be regarded as the nitrate territory.

The value of nitrate of soda as a manure depends chiefly upon its nitrogen; but the soda or base with which the nitrogen is combined has undoubtedly an indirect manurial value, especially where nitrate is freely or constantly used, in virtue of its action in liberating hitherto inactive potash in clay soils and bringing it into service for plant food. Its effect in this direction has been clearly brought out in the field experiments at Rothamsted.

Nitrate of soda is the most rapidly acting of all nitrogenous manures, since its nitrogen is already in the ultimate form into which most other nitrogenous manure is normally converted before being utilized by higher plants; and it acts, in consequence, immediately it is applied —that is to say, directly after the first shower —provided that there is a growing crop ready to take it up. It is especially useful for spring application on soils which have been depleted of nitrates by the drainage due to heavy rainfall during the winter, to keep the plants going until the advancing warmth of the weather leads to fresh soil nitrification.

The principal rival of nitrate of soda for many years past has been sulphate of ammonia, and much evidence has been accumulated in support of the claims of both as the better manure. Generally speaking, however, nitrate of soda is decidedly the better manure for soils lacking in lime, seeing that on such soils the frequent use of sulphate of ammonia tends to deplete the soil of such small quantities of lime as it may contain, and to bring about an unhealthy acid condition —a condition, however, from which the soil can be restored to healthiness by the application of lime. Where there is no reason to fear deficiency in lime, the choice between nitrate of soda and sulphate of ammonia would be influenced by the physical condition of the soil, and also by the prevalent climate.

Nitrate of soda is perhaps more suitable for use on fairly heavy soils than on very light ones, owing to the facility with which it is washed downwards on a very freely draining soil, whereas sulphate of ammonia is less liable to be washed down pending oxidation or nitrification. In some soils, however, the oxidation or nitrification of sulphate of ammonia takes place so rapidly that there is very little difference between its application and that of nitrate of soda. Generally speaking, in a district in which experience would lead us to expect a small spring and summer rainfall, nitrate, other things being equal, is probably preferable to sulphate of ammonia; while in a very wet district sulphate of ammonia would often be preferable. The relative economy of the two manures will sometimes be affected by fluctuations in price, but the balance of experience derived from carefully conducted comparative trials indicates that the nitrogen of nitrate of soda is for most purposes more valuable, weight for weight, than that furnished by sulphate of ammonia.

Unlike sulphate of ammonia, nitrate of soda cannot safely be mixed in more than small quantity with superphosphate without fear of decomposition, unless the superphosphate is very dry or some drying material is added. This is of small moment, however, since nitrate is always best used as a topdressing, whereas it is better to apply superphosphate considerably earlier.

Nitrate of soda should never be used by itself, except on land which, from previous liberal treatment, may be known to be well supplied with unexhausted phosphates and well supplied, either naturally or artificially, with available potash. If this condition be observed—phosphatic manure and potash salts or dung being duly supplied if not already present in the soil —there is scarcely any crop, except crops of the leguminous tribe, which is not capable of being economically benefited by nitrate of soda; and under such proper conditions there need not be any fear of its causing any 'exhausting' effect on the soil. Nitrate should always be used as a spring or summer topdressing—never as a winter manure, owing to its solubility. The dressings to be given for different crops vary considerably. As a topdressing for corn crops the quantity may vary from ¾ cwt. per acre up to 2 cwt. per acre. The latter quantity, however, would only, as a rule, be given to a wheat or oat crop following another straw crop without the application of dung. Under the average circumstances of good farming, 1 cwt. of nitrate per acre would probably be sufficient as a topdressing for most cereals.

For meadows, nitrate may be advantageously used (with phosphates and potash salts) in quantities varying from 1 to 2 cwt. per acre, according to soil, locality, and the age of the pasture. For Italian Rye Grass or other temporary grass leys (as distinguished from permanent grass land), nitrate may be used with advantage in quantities of from 2 to 4 cwt. per acre, divided into two dressings. Its practical value is perhaps most strikingly realized when it is applied to mangolds or to Drumhead cabbages, Thousand-headed Kale, or other plants of the cabbage kind. In conjunction with dung or with phosphates and potash salts it may be remuneratively used for mangolds, on most soils, in quantities of 4 cwt. per acre (divided into two dressings); while for plants of the cabbage kind 4 cwt., or even 6 cwt., will generally be found profitable. In the case of these last-named crops good dressings of superphosphate, dissolved bones, or basic slag should precede the application of the nitrate.

The use of nitrate of soda or other nitrogenous manure is not to be recommended generally for leguminous crops—not, as has been imagined, on account of any antipathy on the part of the plant to artificially applied nitrogen, of which it is ready enough to take advantage; but simply because these plants have other natural means

of obtaining nitrogen, and this makes it wiser economy to reserve such expensive manures for those plants which are less happily endowed. On some soils, however, nitrate of soda has proved to be a valuable adjunct to phosphates and potash salts in the manuring of lucerne.

Nitrate of soda in proper quantities is suitable for almost all garden vegetables and fruit crops, and in the growth of hops it may be used to the extent of 4 cwt. per acre, applied in spring, even where liberal dressings of dung, rape dust, fish guano, &c., are given; while, in the absence of other nitrogenous manures, even 6 cwt. per acre may be used for delicate varieties, and as much as 8 cwt. per acre for freely growing and heavily cropping varieties such as 'Fuggles'. The nitrate should be put on in successive dressings of 2 cwt. per acre each, at short intervals early in the season; its application, however, being preceded by a liberal application of phosphatic manure, and, if necessary, of potash salts.

The prolonged and excessive use of nitrate of soda on the same field has occasionally been observed to exercise a 'panning' action on the soil or subsoil, but under the conditions of ordinary practical farming no such action is likely to occur. Nitrate of soda has been in general agricultural use for very many years, and long experience goes to show that, used in the manner and in the quantities proper to ordinary farming, nitrate rarely produces any unfavourable effect on the physical condition of the soil. Indeed it has been observed that, on some heavy land, the free use of nitrate produces even an opposite effect, namely, a better working condition of the soil. [B. D.]

Nitrates in Soil. See NITROGEN COMPOUNDS IN SOIL.

Nitre.—True nitre is potassium nitrate, or saltpetre, KNO_3, containing as much as 46·5 per cent of potash and 14 of nitrogen. Like soda nitre, it is soluble in water; but it colours the flame of a Bunsen burner violet instead of yellow. It occurs as fibres and crusts in some dry soils, under the same conditions as the far more abundant soda nitre (see art. NITRATE OF SODA); but it is not available for agricultural purposes. The plains of Bengal produce a quantity estimated at 20,000 tons per annum, which is used in the manufacture of gunpowder. It accumulates largely in the neighbourhood of villages as the result of bacterial action on waste products. Most of the potassium nitrate in commercial use is prepared artificially; but it is more economical to supply nitrogen to the soil through soda nitre, and potassium through one of the commercial 'potash salts', than to supply both together in the form of potassium nitrate. [G. A. J. C.]

Nitrification.—For many years it was thought that nitrification was purely a chemical process; the nitrogen of the air, according to some, or ammonia according to others, became oxidized and finally converted into nitric acid. The first exact experiments were made by Boussingault, and proved that nitrification caused no increase in the total nitrogen of the soil; the nitrate must therefore be formed from a compound in the soil and not from the air. Subsequently he found that soil had a specific action in making nitre, and neither sand nor chalk alone was effective. In 1877 Schloesing and Müntz showed that the process is bacterial. Since that time several attempts have been made to revive the chemical hypothesis, but a detailed examination by the writer showed that in each case the experimental evidence was unsound. So far as our present knowledge goes, all the nitrates of the soil are produced by micro-organisms.

The importance of Schloesing and Müntz's discovery can hardly be overestimated, since it really marks the beginning of soil bacteriology. It arose out of a study of the purification of sewage water by land filters. A continuous stream of sewage was allowed to trickle down a column of sand and limestone so slowly that it took eight days to pass. For the first twenty days the ammonia in the sewage was not affected, then it began to be converted into nitrate; finally all the ammonia was converted during its passage through the column, and nitrates alone were found in the issuing liquid. Why, asked the authors, was there a delay of twenty days before nitrification began? If the process were simply chemical, oxidation should begin at once. They therefore examined the possibility of bacterial action and found that the process was entirely stopped by a little chloroform vapour, but could be started again after the chloroform was removed by adding a little turbid extract of dry soil. Nitrification was thus shown to be in all probability due to micro-organisms—'organized ferments' to use their own expression.

Warington had been investigating the nitrates in the Rothamsted soils, and at once applied the new discovery to soil processes. He showed that nitrification in the soil is stopped by chloroform and carbon disulphide; further, that solutions of ammonium salts could be nitrified by adding a trace of soil. By a careful series of experiments he found that there were two stages in the process and two distinct organisms: the ammonia was first converted into nitrite, and then to nitrate. The organisms could not be isolated from the ordinary gelatine plate cultures, and they had to be picked out by the dilution method; it was in this way that Dr. and Mrs. Frankland first obtained an organism in 1890. Shortly afterwards Winogradsky introduced a new method which has enabled him to isolate and make a full study of both organisms. Instead of gelatine plates he used plates of gelatinous silica. A solution of dialysed silica is concentrated to the point at which it becomes gelatinous on adding salt solutions. It is then poured into dishes and rapidly mixed with one or two volumes of a solution of purely inorganic nutrient salts, viz. ammonium sulphate, potassium phosphate, sodium or magnesium carbonate, magnesium and iron sulphates, and sodium chloride. The mixture soon sets to a jelly on which the nitrifying organisms grow and produce very characteristic colonies. They have since been grown on agar.

THE NITRITE-PRODUCING ORGANISM (*Nitrosomonas*, a coccus).—The Western European form, found also in North Africa and Japan, is oval in shape, 0·9 to 1 μ wide, and 1·2 to 1·8 μ long; another from St. Petersburg is round, 1 μ

in diameter, and characterized by the presence of a central nucleus-like body. A small form is found in Java, 0·5 to 0·6 μ only in diameter; a larger one was obtained from South America (Quito, in Ecuador, also from Brazil), 1·5 to 2 μ in diameter. These all occur as free-swimming forms and as zoogloea with certain differences. Whether they are all really distinct organisms or merely variations of one and the same, is not yet settled; it has not been possible to convert one into the other by cultivation, but, on the other hand, only one variety has ever been found in any one soil.

The organism is extraordinarily remarkable in its mode of life. Like the higher plants, it obtains its carbon from carbonic acid and not from organic matter. This was first shown by Winogradsky, though both Munro and Warington had observed that the organism did not require, and might indeed be injured by, the addition of organic matter. Still more rigid proof was furnished by Godlewski, who found that the organisms developed and produced nitrites if supplied with air carefully freed from dust but still containing carbonic acid. On the other hand, there was no nitrite production after the carbonic acid had been removed by potash. The assimilation of carbonic acid is analogous to taking water uphill; it requires the expenditure of energy. Plants possess special chlorophyll cells for the purpose, and derive the necessary energy from light; but these organisms possess no chlorophyll, and they work in darkness! There is little doubt that the energy is obtained by the oxidation of ammonia; indeed Winogradsky found a definite relationship between the amounts of carbon assimilated and of ammonia oxidized. The results of four experiments were:—

	Experiment 1.	Experiment 2.	Experiment 3	Experiment 4.
Ammonia oxidized (expressed as nitrogen)	722·0 mg.	506·1 mg.	928·3 mg.	815·4 mg.
Carbon assimilated .	19·7 „	15·2 „	26·4 „	22·4 „
Ratio $\frac{N}{C}$ . . .	36·6	33·3	35·2	36·4

The mechanism of the oxidation is unknown; there is no evidence that it is brought about by an oxidase, nor has any intermediate product between ammonia and nitrous acid been found. The conversion is almost, but apparently not quite quantitative; about 96 per cent of the ammonia changes to nitrate.

So far as is known, no other carbon compounds can take the place of carbonic acid as food; indeed most of them are harmful. Peptone and glucose are particularly so, but bouillon is tolerated to a far greater extent. It appears that the organisms can in the course of generations become accustomed to certain organic substances, at any rate when other organisms are also present; thus they are active on sewage filter beds, and they are not injured by the humus of the soil. Müntz and Lainé find that peat is not harmful, but on the contrary affords a good medium for growth; indeed they suggest that nitrates could be commercially produced by nitrifying sulphate of ammonia on a peat bed. Further, ammonia is the only nitrogen compound acted upon. Neither urea, asparagin, albumin, bouillon, urea, nor even methylamine is decomposed. Mineral nutrient salts are necessary, including phosphates, common salt, and salts of potash, iron, magnesia, and lime. It is essential, also, that there should be a base like calcium or magnesium carbonate. Gypsum is known to have a beneficial effect. Most salts influence the process, and retard it when present to excess; a number of quantitative determinations are given by Boullanger and Massol.

The Nitrate Organism.—This was isolated by Winogradsky in 1891, and can be grown on nitrite-agar plates. It is rod-shaped, less than 1 μ long, and between 0·3 and 0·4 μ thick. Only one variety has been recognized.

Like the nitrite organism it obtains its carbon from carbonic acid. No doubt it derives the necessary energy from the oxidation of nitrite, which appears to be its sole nitrogenous food. Ammonia acts very injuriously, as little as ·0005 per cent checks development and ·015 completely inhibits it; but the organism is much less sensitive in mixed cultures. Organic matter also acts injuriously, but not to the same extent as on the nitrite organism. Kaserer has recently claimed to have discovered an organism which converts ammonia direct to nitrate.

Nitrification in Soils.—In the soil the two organisms work together and the separate stages cannot be distinguished. Moreover, the organisms are much less sensitive to organic matter and to ammonia than they are in pure cultures. They occur mainly in the top 9 in. of soil. The ammonia produced from organic matter by other organisms is nitrified as fast as it is formed; the rate of nitrification is thus limited by the rate of ammonia production. Ammonium salts added as manure are rapidly nitrified, and even in forty hours Warington found distinct change had taken place. The effect of temperature is very marked: during cold weather nitrification is retarded, and the supply of nitrate may be cut off just when plants have most need of them; the result is a yellowing of the plant. Nitrification is not *essential* to fertility; plants can live quite well on ammonium salts. It is, however, an economical process as a rule; and 1 lb. of nitrogen as nitrate leads to a greater production of crop than 1 lb. of nitrogen as ammonia.

[E. J. R.]

Nitro-bacterine.—Pure cultures of nitrogen-fixing bacteria grown from organisms taken from the nodules of each species of leguminous plant and similar to those formerly sold as Nitragin. See Nitragin.

Nitrogen (Azote) is a colourless gas, existing in the free state in the atmosphere, of which it forms four-fifths by volume. It is very widely

distributed in nature, in combination with other elements. It is an essential plant food, and forms a constituent of both plant and animal material. Most plants assimilate their nitrogen as nitrate, some as ammonium salts, whilst plants belonging to the Leguminosæ can, in addition, assimilate free nitrogen. Animals take in their nitrogenous foodstuffs in the form of nitrogenous compounds, namely proteids, which are compounds containing carbon, hydrogen, oxygen, nitrogen, sulphur, and sometimes phosphorus, and which are manufactured by, and stored up in plant organs.

Pure nitrogen gas does not support life, death being caused by suffocation. Many nitrogenous compounds stored in plants possess valuable medical properties, others act as powerful poisons. Certain oxygenated compounds of nitrogen are highly explosive. In fact, unlike free nitrogen, many of its compounds are characterized by great chemical activity. Nitrogen is a constituent of protoplasm, nervous tissue, and of all living plant and animal tissues. It forms a large number of highly important compounds.

[R. A. B.]

Nitrogen, Loss of from Soils.—It has been shown in the art. NITROGEN FIXATION IN SOILS that the soil is constantly gaining nitrogen, and in the arts. DENITRIFICATION and DRAINAGE WATER that it is constantly losing nitrogen. In cultivated soils the losses predominate, whilst in pasture soils the reverse happens and there is a gain in nitrogen, which is, however, ultimately balanced by the losses. Although the total magnitude of the changes cannot be estimated, it is not difficult to ascertain the net result, and experiments with this object have been made in several places. After taking account of the nitrogen in the crop or accumulating in the soil there is always a certain loss that cannot be accounted for, the dead loss or net loss. Some of the Rothamsted data are:—

Plot No.	Manuring.	Nitrogen supplied in Manure per annum. lb.	Nitrogen recovered in Crop per annum. lb.	Net loss of Nitrogen per acre per annum. lb	
				From top 9 in. of Soil.	From top 27 in. of Soil
3	Unmanured	—	19	—	—
5	Full minerals only	—	24	6	—
7	Full minerals + ammonium salts	86	49	44	65
10	Ammonium salts only	86	34	68	55
11	Ammonium salts + super.	86	39	59	53
12	Ammonium salts + super. and sulphate of soda	86	41	53½	48
13	Ammonium salts + super. and sulphate of potash	86	45	51	37
14	Ammonium salts + super. and sulphate of magnesia	86	44	47½	47
2	Dung	200	56	131	140

The plots receiving chemical manure are being slowly impoverished in spite of the heavy dressings of ammonium salts.

The loss on the dunged plot is very great, and is much higher than would arise in ordinary farm practice, where dressings would be less frequently applied. It is, however, quite comparable with the losses taking place when rich virgin soils are first brought into cultivation and cropped continuously with wheat. Thus Snyder (Minnesota Station Bulletin 89, p. 193) has shown that a prairie soil continuously growing wheat for twelve years lost nitrogen at the rate of 170 lb. per acre per annum, only about 37½ lb. being recovered in the crop; making a dead loss of 132½ lb. each year per acre. At the Indian Head Experimental Farm, Sask., Canada, the top 8 in. has been found to lose 100 lb. per acre per annum during the past twenty-two years, of which less than 32 lb. has been removed in the crop.

It is difficult to say exactly what loss of nitrogen might be expected to arise in ordinary arable farming, but it ought certainly to be much less than the losses quoted above, since the applications of manure are smaller and less frequent. Where the dung is applied at Rothamsted only once in four years about two-thirds of the nitrogen is recovered, the rest being partly laid up in the soil and partly lost.

The two most serious sources of loss are: (1) drainage, (2) bacterial action.

LOSS BY DRAINAGE.—Of the various nitrogen compounds in the soil, nitrates alone appear to suffer any appreciable loss by drainage. Their ready solubility is an advantage so long as a crop is on the ground to take them, but a disadvantage under other circumstances, since it leads to their being washed away. The nitrate lost from the Rothamsted drain gauge contains on the average 31·4 lb. of nitrogen per acre per annum, or 188 lb. of nitrate of soda, worth about 17*s*. This land is kept fallow; if it were cropped the loss would be reduced by whatever quantity was taken by the crop. Dehérain has made a series of pot experiments and determined the nitrates in the drainage water with the following results:—

	Inches of Drainage.		Nitrogen as Nitrate in Drainage Water. lb. per acre.
Uncropped, uncultivated	11·2	......	186·7
Wheat	7·5	......	28·7
Wheat succeeded by vetches	6·6	......	12·9
Rye Grass	7·8	......	2·3
Oats	7·3	......	7·4
Sugar beet	7·2	......	0·3

Total rainfall during the period, 28·8 in.

It has been found at Rothamsted that neither

sulphate of ammonia nor nitrate of soda persists in the soil, although they may lead to the production of more leaf or stubble to be ploughed in and thus indirectly increase the soil nitrogen. A wet autumn and winter is known to act unfavourably on the wheat crop; indeed Dr. Shaw has shown that every inch of rain falling between the 36th and 48th week of the year depresses the yield by 1¼ bus. (Proceedings of the Royal Society, 1905, 74, p. 552). For a number of years, with certain easily understood exceptions, the yield of wheat is 39·5 bus. —⅘ previous autumn rainfall. One very important reason is that during this period nitrates are being washed out from the soil, and the heavier the rainfall the more complete the process. *It is often noticed on light sandy or gravelly soils that larger crops are obtained on* places where ricks stood throughout the winter than elsewhere: the explanation is that the rick kept off the rain and protected the nitrates from being washed away.

There are two methods of reducing the loss: (1) to use well-balanced manures during the rotation, so that the preceding crop may take up a large amount of the nitrates present; (2) to leave the land uncropped as little as possible consistent with good tillage.

The first method is applicable everywhere. Its effectiveness is well illustrated by comparing Plots 10 and 13 of the Broadbalk wheatfield:—

	Crop per annum		Average Loss of Nitrogen to 27 in. depth. lb per acre.	Nitrogen as Nitrate in Drainage Water running away during Autumn.
	Grain (bushels).	Straw (cwt).		
Plot 10.—Badly balanced manure (nitrogen only)	16·0	14·75	55	17·8 parts per million of water.
Plot 13.—Better balanced manure (complete minerals and nitrogen) ...	26·7	30·75	37	8·5 ,, ,, ,,

The wastage of nitrogen has been reduced, and consequently the crop is increased; Plot 13, moreover, contains more nitrogen than Plot 10.

The second method is of more limited application, because certain soils must at intervals lie uncropped during autumn and winter in order to clean the land and get a tilth. Instances are furnished by catch cropping, 'bastard' or 'rag' fallowing, and sowing seeds with corn. The crop will, during late autumn and winter, take up nitrates which would otherwise be washed away. In Dehérain's experiment referred to above, the drainage water from soil cropped with wheat alone carried away 28¾ lb. per acre of nitrogen in the form of nitrates during the year, but from soil cropped with wheat followed by vetches the loss was reduced to less than 13 lb. per acre.

Loss by Bacterial Action on Nitrates or on Organic Matter.—Two types of bacterial action cause an absolute loss, and are described in detail under Denitrification. (1) Certain bacteria decompose nitrates with liberation of the nitrogen as gas. This change only goes on in absence of air, and there is no evidence that it takes place under conditions obtaining in British agriculture, except perhaps when the soil remains very wet for any length of time. (2) Other organisms liberate nitrogen during the decomposition of organic matter in presence of air. They act in the soil whenever the condition of the land becomes high, and thus prevent an indefinite accumulation of fertility; no doubt they are mainly responsible for the losses from the Broadbalk dunged plots and the prairie wheat soils. No method is known for preventing the loss, but there are two ways of minimizing its effects, both of which are practised in highly farmed districts. (1) By proper use of lime, potash, or phosphoric acid, by suitable cultivation methods, and by adopting an appropriate sequence of crops. Thus on the Rothamsted mangold plots the effect of a well-balanced manure in increasing the amount of nitrogen recovered is as follows:—

	Roots, tons per acre.		Nitrogen recovered, lb. per acre.
Badly balanced manure (organic manures and sulphate of ammonia)...	24·7	......	134·4
Better balanced manure (the above + potash and phosphatic manures)...	29·3	......	172·0

The heavy dressings of dung alone, or of dung and nitrate of soda, sometimes used for mangolds and even for potatoes, are wasteful, and could often be improved by substituting potash or phosphatic manures for some of the dung. It is no use letting nitrogen accumulate in the soil: the aim should be to keep it circulating, to crop it out and replace it by manure, by feeding on the land, ploughing in green crops, by growing leguminous crops, &c. (2) The second method of dealing with these losses is to counteract their effect by bringing about a corresponding gain, and periodically growing a seeds mixture containing clover: this is discussed under Nitrogen Fixation in Soils.

[E. J. R.]

Nitrogen Compounds in Soil.—The nitrogen compounds of the soil differ fundamentally from the phosphorus, potassium, calcium, and other compounds in that they all arise through the agency of some living organism. They form no part of the fundamental igneous rock from which the purely mineral constituents are derived, but arise always from the decay of plant and animal matter. To trace the process farther back, they originate in the fixation of nitrogen by certain organisms of the soil, and then go through a cycle of changes in the

course of which they may become incorporated in plants and pass through animals.

The greater part of the nitrogen compounds appear to be present in the form of complex organic bodies, no detailed study of which has yet been made. A simple substance, ammonia, is found in minute quantities, and is doubtless a product of decay; no intermediate compound has so far been isolated, although a number are probably produced. Two other simple substances are formed from ammonia—nitrates, which are invariably present, and nitrites, found only in exceptional cases. It is customary to distinguish by the name 'humic nitrogen' that fraction of the total nitrogen which is soluble in alkalis, and to suppose that it represents the nitrogen present in the humus; the assumption is quite unfounded, since other compounds, *e.g.* the purin bases, dissolve in alkalis and are, like humus, precipitated by acids.

With the exception of nitrates and nitrites, all the nitrogen compounds in the soil are readily retained by the soil and do not wash out to any appreciable extent, no matter how soluble they may be in pure water. An insoluble compound is formed which remains where it is produced until it is converted into nitrates, when it may wash away. Thus, no matter how highly a soil is manured, the surface soil alone shows any gain in nitrogen; the subsoil shows no increase. Indeed the only way of enriching the subsoil in nitrogen (apart from trenching and actually digging in the manure) is to grow deep-rooting crops. An admirable illustration is afforded by the soils of the Broadbalk wheatfield: the surface soils alone show any variation in their nitrogen content according to their manurial treatment, while the subsoils are practically all alike. The most remarkable contrast is that of the dunged and the unmanured plots. At the end of fifty years the former had received 700 tons of dung containing 10,000 lb. of nitrogen, while the latter had received nothing, yet at a depth of 9 in. and beyond the two soils show very little differences. The figures are given below:—

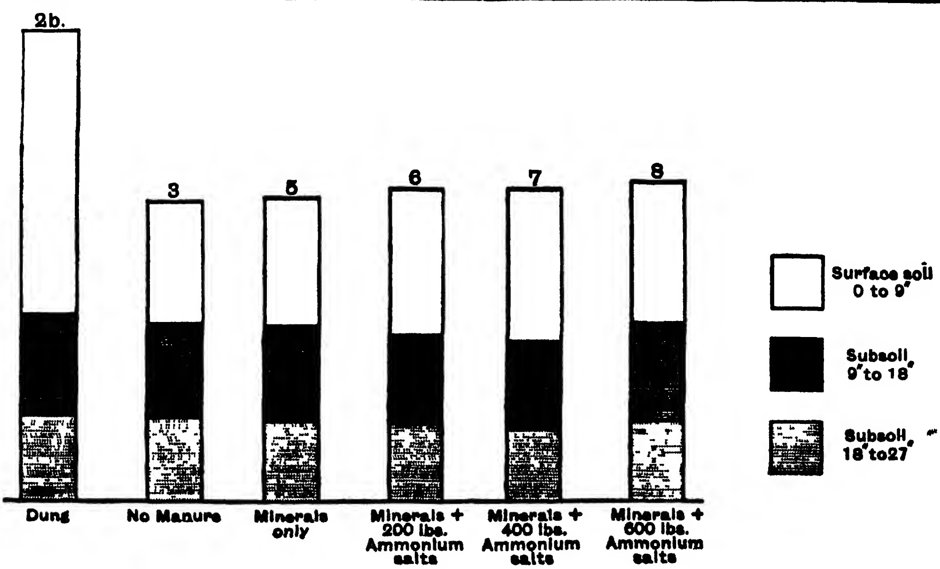
NITROGEN IN BROADBALK WHEAT SOILS, 1893

Per cent of dry soil

Manuring.	Unmanured	Dung.	Minerals only.	Minerals + 200 lb. Ammonium Salts.	Minerals + 400 lb Ammonium Salts	Minerals + 600 lb. Ammonium Salts.
Plot No.	3	2*b*	5	6	7	8
Nitrogen supplied in manure	—	10,000 lb.	—	2150	4300	6450
Top 9 in.	·0992	·2207	·1013	·1107	·1222	·1188
9 to 18 in.	·0730	·0767	·0739	·0720	·0681	·0752
18 to 27 in.	·0651	·0656	·0645	·0628	·0583	·0630

lb per acre

Top 9 in.	2572	5150	2630	2870	3170	3080
9 to 18 in.	1950	2050	1970	1920	1820	2010
18 to 27 in.	1820	1830	1800	1750	1630	1760



The results are shown on the diagram.

The relative amounts of the various nitrogen compounds in the top 9 in. of soil are approximately as follows, taking the total amount of nitrogen as 1000:—

Nitrogen soluble in alkalis ('humic' nitrogen)	530
Nitrogen as ammonia	2
Nitrogen as nitrate	4 to 20
Nitrogen as other compounds ...	464 to 444
Total	1000

Neither the 'humic' nitrogen nor the ammonia changes much in relative amount on the different plots; the nitrate alone of the known compounds shows variation. The nitrate is formed only from ammonia, and it is clear that the process goes on as quickly as the ammonia is produced. The 'other compounds' include (*a*) an unknown but probably large amount of resistant matter which will only decompose slowly under natural conditions, and which arises in part from the organic matter deposited originally with the soil; (*b*) plant remains which are not yet decomposed; (*c*) the intermediate substances, whatever they are, between the complex nitrogen compound and the ammonia; (*d*) by-products in the decomposition.

'Humic' Nitrogen.—About half of the nitrogen of an arable soil, and two-thirds of the nitrogen of a pasture soil, can be extracted by dilute alkalis, and is therefore commonly supposed to be in the form of humus. As already pointed out, the assumption is unsound, since a number of nitrogen compounds are known which dissolve in alkalis and are reprecipitated by acids. It is also supposed, again without much evidence, that this 'humic' nitrogen furnishes the chief source of nitrate. The ratio of humic to total nitrogen is, on this assumption, of importance in estimating the fertility of the soil, and has been studied by Hilgard in America. Determinations made at Rothamsted lend no support to this view, but show that the most exhausted and most fertile plots have the same ratio:—

Humic Nitrogen, expressed as Percentage of Total Nitrogen

Broadbalk, unmanured	51·76
,, dunged	52·53
Meadow soil	66·8
Prairie soil (Manitoba)	37·25

Fuller investigation of the subject is required.

Ammonia.—It was at one time thought that rather large amounts of ammonia were present in the soil, but subsequent work showed that only about 4 parts occur per million of soil, and more recent determinations indicate that even this is rather high. The amount does not show much variation with the season in ordinary soils, because ammonia is produced at a slower rate than it can be converted into nitrate, hence only a minimum quantity is ever present. On acid soils, where the conditions are unfavourable for nitrification, moulds occur which can assimilate ammonia. Ammonia reacts chemically with certain constituents of the soil, producing insoluble compounds, which, however, can be nitrified, and also with humus to form a stable compound which does not seem to be nitrified so readily: all these therefore tend to conserve ammonia. Thus, when an ammonium salt is added to the soil a certain amount of ammonia at once goes into combination and ceases to behave like ammonia; if the soil is kept moist and warm, the remainder of the ammonia soon changes into nitrate. If, however, the nitrifying organisms have been destroyed by heating the soil or treating with toluene, the ammonia gradually accumulates.

In 1893 Müntz and Coudon proved, what had long been assumed, that ammonia is formed in the soil by micro-organisms. When soil was sterilized at 120°, production of ammonia ceased entirely, though not when the temperature had only been raised to 110°. In the following year Marchal made a detailed study of several of the soil organisms, and in particular of *Bacillus mycoides*, which he found by much the most vigorous ammonia producer. It decomposed albumin and other proteins, but had no effect on urea. It did not assimilate either ammonia or nitrates. Other organisms are known which decompose urea to yield ammonia.

When protein decomposes it breaks down to various amino acids and certain bases, such as the amines and purin bases, finally a certain amount of ammonia is formed. Probably this same reaction takes place in the soil, but definite evidence is as yet wanting. Nor is it known whether protein added to the soil is quantitatively converted into ammonia, or whether some of it changes to stable by-products which break down much more slowly.

Nitrites.—Only in exceptional circumstances are nitrites found in soils, and then they probably arise from reduction of nitrates and indicate defective aeration. They are said to be present in certain paddy soils of the East after application of nitrate of soda; the soils are waterlogged and denitrification sets in. They are not found in properly aerated soils.

Nitrates, on the other hand, are invariably present. They are easily soluble in water, and, unlike ammonia, are not retained by the soil. They show no tendency (nor indeed do any other salts) to spread in the soil: the Rothamsted grass plots show to an inch where the nitrate has gone, although large dressings have been applied annually for over fifty years. They wash straight down into the subsoil; but Warington (in an article in the Transactions of the Highland and Agricultural Society, 1905, p. 148, which contains a number of important data bearing on the present subject) has adduced evidence to show that they may be brought to the surface again in certain cases; the ordinary assumption that nitrate of soda has no effect the year after its application is therefore not always true. Nitrates are readily taken up by plants, provided all the conditions are favourable.

Nitrates are produced in the soil by the agency of bacteria (see Nitrification) which are very sensitive to changes in temperature, air supply, and the presence of harmful sub-

stances, and only work at their best in a well-cultivated, properly drained soil sufficiently supplied with calcium carbonate. They are destroyed by numerous bacteria in absence of air (see DENITRIFICATION), and consequently decrease in amount when the soil becomes waterlogged. They are also absorbed by algæ and probably by other organisms.

These facts enable us to interpret the results obtained by actual analysis of soils. In early spring the amount of nitrate present is very small, in an ordinary arable soil about 1 to 5 parts of nitrogen per million of dry soil (·0001 to ·0005 per cent, the total nitrogen being about ·15 per cent). As the soil becomes warmer, considerable quantities of nitrate are formed, but their fate depends on circumstances. If a crop is growing the nitrate is taken up, and the amount in the soil shows no increase, but remains at 1 to 5 parts per million. If there is no crop, not even weeds, the nitrates accumulate, and in August or September may rise to 15 to 50 parts per million of dry soil (·0015 to ·005 per cent), unless heavy rain has in the interval washed them out. In winter the production of nitrate is reduced to a minimum, and only washing out goes on; the amount is steadily reduced till the minimum is reached in spring, just before the soil begins to warm up again. At this period fluctuations in amount are most sharply felt, because the young crop is in most need of nitrate; during a cold snap the production of nitrate ceases.

Generally speaking, sandy soils only contain small quantities of nitrate because of the ease with which water passes through. Heavy, badly aerated clays also do not contain large quantities. Loams are usually richer than any other class of soil in nitrates. Manuring naturally has a great effect. The plots on the Broadbalk wheat field were found to contain in October, 1893, after the crop was removed, the following amounts of nitrogen as nitrate in one million parts of dry soil:—

Manuring.	Unmanured.	Complete Minerals, no Nitrogen.	Complete Minerals and Ammonium Salts.	Ammonium Salts alone.	Dung.
Plot No.	3	5	7	10	2*b*
Top 9 in.	3·72	4·06	5·77	4·83	4·51
Second 9 in.	3·45	2·38	7·19	9·52	16·98
Third 9 in.	·98	·80	3·06	4·03	4·39
Lb. per acre in top 27 in.	21·60	19·12	42·71	49·20	68·14

The greatest amount is present on the dunged plot, smaller amounts occur in the plots receiving ammonium salts, and still less on Plots 3 and 5, where no nitrogenous manure is added. The differences persist even at 90 in., the greatest depth sampled, and show that no lateral diffusion goes on.

See also arts. DRAINAGE WATER and CULTIVATION. [E. J. R.]

Nitrogen Fixation in Soils.—

1. BY BACTERIA ASSOCIATED WITH LEGUMINOUS PLANTS.—It has been known from time immemorial, and is recorded by Virgil, that lupins or vetches form a good preparation for wheat, and later writers like Pliny and others endorse this view. Many cases are on record where leguminous crops have effected great improvement in the soil, a classical instance being furnished by the Schultz-Lupitz estate in Altmark, North Germany. Fifty years ago this was a barren sand; it was manured with lime, potash, and phosphoric acid, and cropped alternately with lupins and cereals. The lupins were either ploughed in or fed, and so increased the amount of nitrogen and organic matter that the barren sand was after a time converted into a rich soil, capable of growing a large variety of crops. This excellent result had been obtained without buying in any nitrogenous manure. In our own country the late Mr. Mason, of Eynsham Hall, Oxon, effected a marked and permanent improvement in some poor Oxford clay by deep cultivation, treatment with basic slag, and sowing with lucerne. Wherever a good plant was obtained, the soil was considerably enriched in nitrogen; as the ley got old it was either converted into meadow by sowing appropriate grass seeds, or else ploughed up and put into corn and roots.

A gain in nitrogen was recorded many years ago by Boussingault when clover came into the rotation, but not when corn crops alone were grown. It was found at Rothamsted that clover not only contained a larger amount of nitrogen (which was removed in the hay) than a cereal crop, but also left a larger amount of nitrogen in the soil which would benefit the succeeding crop. A piece of ground was cropped with cereals for five years without nitrogenous manure, and was then divided into two parts: on one a crop of clover was taken, on the other barley was grown. After the crops were removed, samples of soil were taken for analysis, and then barley was grown on both plots. The analytical results were:—

	Plot where Clover was grown.	Plot where no Clover was grown.
Nitrogen in crop (1873)	151·3 ... (in clover)	37·3 lb. per acre. (in barley)
Nitrogen left in soil after crop was removed (1873) ...	·1566 ...	·1416 per cent.
Nitrogen in crop (1874)	69·4 ... (in barley)	39·1 lb. per acre. (in barley)

Numerous other analyses led to the same result. Lawes and Gilbert thought the nitrogen came from the subsoil, and there was nothing to show that they were wrong; whilst on the other hand Boussingault in 1837, and later Ville, Voelcker, and others, expressed the opinion

that it came from the air. Field experiments alone were insufficient to solve the problem; it was not till 1886 that Hellriegel and Wilfarth used a totally different method, and proved conclusively that nitrogen was fixed from the air by bacteria associated with the roots of the Leguminosæ. They were investigating the relation between the amount of nitrogen supplied and the plant growth; and found that oats, barley, &c., would not grow in sand cultures where no nitrogen was supplied, but gave a steadily increasing crop as more and more nitrogen (as calcium nitrate) was added. Leguminous plants, however, behaved differently, and showed no relationship between the nitrogen supplied and the yield obtained. After the seedling stage was passed, the plants grown without nitrogen made no further progress for a time, then some of them started to grow and did well. This period of no growth was not seen where nitrogen was supplied. Two of their experiments are as follows:—

Nitrogen supplied per pot, grammes	—	·056	·112	·168	·224	·336
Weight of oats obtained (grain and straw) ...	·3605 ·4191	5·9024 5·8510 5·2867	10·9814 10·9413	15·9974	21·2732 21·4409	30·1750
Weight of peas obtained (grain and straw) ...	·551 3·496 5·233	·9776 1·3037 4·1283	4·9146 9·7671 8·4969	5·6185	9·7252 6·0458	11·3520

The duplicate pots agree well in the oats series, but show no sort of agreement when peas are grown.

Analysis showed that the nitrogen contained in the oat crop and soil at the end of the experiment was always a little less than was originally supplied, but was distinctly greater in the case of peas; the gain in three cases amounted to ·910, 1·242, and ·798 grm. per pot respectively. They drew two conclusions: (1) the peas took their nitrogen from the air; (2) the process of nitrogen assimilation was conditioned by some factor which did not come into their experiment except by chance. In trying to frame an explanation they connected two facts which were already known. Berthelot had shown that certain micro-organisms in the soil can assimilate gaseous nitrogen. It was known to botanists that the nodules on the roots of Leguminosæ contained bacteria. The following considerations showed that nitrogen assimilation was brought about by bacteria in the nodules: (1) peas made only small growth and developed no nodules in sterilized sand without addition of nitrogen; when calcium nitrate was added they behaved like oats and barley, giving regular increases in crop for each increment of nitrogen; (2) they grew well and developed nodules in sterilized sand watered with an extract of arable soil; (3) they sometimes did well and sometimes failed when grown without soil extract and without nitrogen in *unsterilized* sand which might or might not contain the necessary organisms. An extract that worked well for peas might be without effect on lupins or serradella. In other words, the organism is specific. At a later date Schloesing *fils* and Laurent showed that the weight of nitrogen absorbed from the air was equal to the gain by the plant and the soil, and thus finally clinched the evidence.

The organism was isolated and studied by Beijerinck, and is called *Bacterium radicicola.* It occurs as a free-swimming stage 0·9 μ long and 0·18 μ wide, and also forms rods 4 to 5 μ long and 1 μ wide. When it gets into the nodule it changes into the bacteroid T and Y forms which have recently been obtained in artificial culture by adding suitable reagents to the medium. It does not fix much nitrogen when grown artificially in the ordinary way, but Golding has shown that fixation is increased by removing the products as fast as they are formed, and thus reproducing the conditions that obtain in the plant. The course of the reaction is quite unknown; it may be supposed that the plant furnishes carbohydrate as food and source of energy to the organism, and draws away the nitrogen compounds formed. The process seems to be associated with bacteroid formation. The maximum amount (5·2 per cent) of nitrogen in the nodule occurs at the time of blooming.

The organisms appear to become modified by association with a particular leguminous plant; thus the pea organism differs from the lupin organism. There is, however, evidence to show that the organisms are not fundamentally different.

Pure cultures of the various organisms have at times been used for soil inoculation in field work (see INOCULATION OF SOIL).

Other plants, *e.g.* the Alder, also develop nodules by which nitrogen is fixed, and others again are associated with mycorhiza, which may fix nitrogen.

2. FIXATION OF NITROGEN BY OTHER MICRO-ORGANISMS.—It was Berthelot in 1885 who first showed that nitrogen could be fixed by soil on which no crop was growing. He had for some years been interested in the nitrogen question, and had shown that nitrogen was absorbed by certain organic compounds under the influence of the silent electric discharge, or even of such discharges as might commonly occur in nature; indeed he at one time supposed this to be the method by which nitrogen was fixed in nature. But the experiments made in 1884 and 1885 showed that two sands and two clays initially very poor in nitrogen (·01 per cent or less) contained distinctly more after five months' exposure to air, even when kept in large closed flasks. If, however, the soil was previously heated there was no gain in nitrogen; the action was therefore due to micro-organisms. He further showed that soil carrying vegetation also

fixed nitrogen. Ten years later Winogradsky isolated from garden soil an anaerobic organism, *Clostridium pasteurianum*, which fixed nitrogen from the air. In 1901 Beijerinck isolated an aerobic nitrogen-fixing organism which he called *Azotobacter*, and which has since been found widely distributed on soils containing sufficient calcium carbonate. In a later paper he states that the organism only works in symbiosis with others; but it is now known to be able to work alone, although in the soil it may live in symbiosis with algæ and others. Two varieties have been described by him—*Azotobacter agilis* and *A. chroococcum*. Both are large and oval, 4 to 6 μ in diameter, and, unlike most other organisms, contain glycogen, and therefore stain a red-brown colour with iodine; they also stain well with aniline colours. (Lipman has described three others: *A. vinelandii*, *A. beijerincki*, and *A. woodstownii* (New Jersey Report, 1904, 237).) The organism is very rich in nitrogen, and when dry may contain as much as 10 to 12 per cent, corresponding to nearly 80 per cent of protein; it also contains about 9 per cent of ash, mainly potassium phosphate.

The conditions under which the organism works are—(1) presence of air, (2) oxidizable organic matter, (3) calcium carbonate to prevent the medium becoming acid, and (4) a supply of mineral food. Magnesium carbonate can apparently replace calcium carbonate. Respiration is more vigorous than in any organism yet studied, and 1 grm. of the bacterial mass evolves 1·3 grm. of carbon dioxide in twenty-four hours. The presence of the oxidizable organic matter is of course necessary to supply energy for the fixation of nitrogen, and many experiments have been made to discover the most suitable compounds. Sugar is generally used in culture solution, either mannite or dextrose, but arabinose has been found most effective, and it has therefore been concluded that the furfuroids of the soil furnish the most suitable food for the organism in natural conditions. Humus, however, seems to be of considerable importance. The amount of nitrogen fixed for every gramme of organic substance oxidized varies rather widely with the conditions of the experiment. Winogradsky found that *Clostridium* fixed 1·5 to 1·8 mg. of nitrogen for every gramme of sugar used up. Gerlach and Vogel showed that Azotobacter fixed 7·5 to 12 mg. per gramme of glucose used up. Another organism, *Radiobacter*, commonly associated with Azotobacter, and at one time credited with considerable powers of nitrogen assimilation, only fixes 0·2 to 0·5 mg. per gramme of glucose used up. The sugar is converted into carbon dioxide, water, and small amounts of ethyl alcohol, hydrogen, formic, acetic, butyric, and lactic acids.

Action in Promoting Fertility.—It is not certain how far these organisms are active in ordinary arable soil, although there is evidence that some fixation does take place. Their action is easily traced on land where the vegetation is allowed to die back, or on pasture land. An arable field laid down to grass at Rothamsted gained between 50 and 60 lb. of nitrogen each year in the top 9 in., whilst a piece of land allowed to run wild gained 100 lb. annually in the top 27 in. over and above any loss. In both cases, however, leguminous plants were present, and it is difficult to say how much of the increase is due to their action and how much to Azotobacter. Hall has adduced evidence to show that most prairie lands came by their stock of nitrogen through the action of Azotobacter. Koch has obtained notable increases in crop by adding sugar to the soil and thus increasing the amount of nitrogen fixation. The immediate effect was to depress the crop, but subsequently great increases were obtained:—

	Oat Crop, 1905. Dry Matter obtained.	Nitrogen in Soil in April, 1906; per cent.	Buckwheat Crop, 1906.	
			Dry Matter obtained.	Nitrogen taken up by Crop.
No sugar added	100	·095	100	100
Sugar added to soil	93·3	·102	279·7	263

It is interesting to note that waste molasses have been found to increase the yield of sugar cane in Mauritius. Mr. Ebbels has obtained evidence that the Azotobacter are thereby rendered more effective and increase the nitrogen supply of the plant. Whether such results could be obtained in Great Britain, where the soil temperature is lower, has yet to be ascertained.

[E. J. R.]

Nitrogenous Organic Manures.—A large amount of nitrogenous material is applied to the soil in the form of organic manures. All plant and animal substances contain nitrogen and can be used as manure. The excreta of animals and farmyard manure itself are organic manures which supply nitrogen but at the same time supply phosphate, potash, and all the other constituents required from the soil by plants. Dung is therefore an all-round manure, and the manures which are distinctively referred to as nitrogenous organic manures are those which are not all-round manures but are manures used mainly or entirely on account of the nitrogen which they contain. It is only such manures which it is proposed to refer to in this article.

The distinctively nitrogenous organic manures are practically all of animal origin. They include manures made from the skin of animals and its appendages, such as hair, wool, feathers, horn, hoof, and fur; manures made from glue refuse, blood, flesh, and silk. Their value and activity as manures is closely related to the readiness with which they undergo decay and liberate their nitrogen in forms suitable for use by crops.

These manures, like all other organic manures, have a certain value on account of their effect on the mechanical condition of the soil. The organic matter of which they are composed is capable of absorbing and holding water, and thus adds to the water-holding capacity of the soil. Decaying organic matter also improves the texture of the soil. It helps to keep heavy soils open and porous, while it binds and ameliorates the too open condition of light soils. An inorganic salt like sulphate of ammonia or nitrate of soda does not benefit the soil except by supplying it with nitrogen; but organic nitrogenous manures have in addition to their nitrogen a small value on account of the organic matter which they supply.

Several of the nitrogenous organic manures have been used as manures for ages. Wool in the forms of wool waste and woollen rags has been held in high esteem in England as a manure for centuries. Similarly horn dust and shavings, skin, hair, feathers, blood, fish, flesh, malt dust, and other substances are all mentioned in old writings on agriculture.

Wool.—In the pure dry state wool contains 16 or 17 per cent of nitrogen. It is used in the forms of shoddy, wool waste, and waste woollen clippings and trimmings. Shoddy is the substance obtained when woollen rags are shredded in order to be remade into cheap cloth. The short wool and waste, which are not fit to make up again into cloth, and which form a considerable portion of the whole, go for manure under the name of shoddy. This is by no means pure wool, but contains dirt, cotton, and more or less oil. The greater the proportion of impurities mixed with the wool the lower the percentage of nitrogen and the lower the value of the manure. Shoddies are met with containing all percentages of nitrogen from about 13 to as low as 2. Cotton does not contain any nitrogen, and the greater the proportion of this fibre which has been mixed with the wool the lower the value of the shoddy. Shoddies are divided into various grades. High-grade shoddy will contain from 10 to 13 per cent of nitrogen, equal to about 12 to 16 per cent of ammonia. The percentage of nitrogen in shoddy is commonly quoted in terms of ammonia. Ordinary shoddies may contain from 5 to 10 per cent of nitrogen, equal to about 6 to 12 per cent of ammonia, while low-grade shoddies contain still lower percentages of nitrogen and are mainly composed of cotton and impurities.

Shoddy has long been highly esteemed as a manure for certain crops, such as hops and grapes. It is also used in horticultural work, and as an ingredient of the lower class of mixed manures. The wool in shoddy is finely broken up by the mechanical processes to which it has been subjected, and if not too oily decays with comparative readiness in the soil. At the same time it yields its nitrogen only gradually to crops, and hence its action is more prolonged and not so forcing as that of soluble salts like nitrate of soda. It is this gentle and prolonged action which particularly recommends it and other manures of this class to the growers of hops, vines, roses, and other plants which, while they are benefited by a highly nitrogenous manure, are best served if the action of the manure is not too forcing.

A certain amount of waste material is also produced by mills which make cloth of fresh wool and employ no shoddy. In the treatment of the wool, broken fibres, wool dust, and other refuse particles containing wool accumulate. This wool waste often contains much oil and dirt, which greatly reduces its value. It can generally be obtained for very little, especially from the smaller wool mills in country places, which do not produce a large quantity of this waste. In some cases, where its value is little known, the producers are glad to get rid of it by giving it away free. As this substance, like shoddy, has a considerable manurial value, it is well worth taking when it can be obtained cheaply.

Horn.—When combs and other articles are made from horn the greater part of the horn is removed as waste. These horn parings, horn clippings, &c., form a manure of considerable value. Horn has a very similar chemical composition to wool, and in the pure dry state contains about 17 per cent of nitrogen. The waste is obtained in an almost pure condition, and the horn dust and horn shavings of commerce contain from 14 to 16 per cent of nitrogen, equal to from 17 to 19½ per cent of ammonia.

Horn manures are also much esteemed. They are used chiefly for vines, roses, and horticultural work. Horn is also a constituent of mixed manures, especially those adapted for horticultural purposes.

Besides the horn waste derived from works which make horn goods, much horn is obtained as a waste product from the slaughtering industry. It is only certain classes of fully matured horns which are fit for use in making horn goods. A very large proportion of the horns of beef cattle are not fit for such use, and are merely ground up to make manure. Many of these are ground up along with the bones and add their nitrogen to that of the bone meal, but others are ground up to form horn meal. Very similar to horn is hoof, and it is also ground up to form manure. Horns and hoofs are commonly ground together to form horn and hoof meal. The horn shavings and dust derived from comb works are generally sent out in a very fine state of division. The same is not always true of the horn and hoof meal from slaughter-houses. Horn is so insoluble and decays so slowly when in lumps that it should always be very finely ground before it is used as manure.

Hair and Feathers.—Hair and feathers are of similar composition to wool and horn. All of these are composed principally of a protein substance called keratin. This substance is a principal constituent of the epidermis of animals, of which the horn, hoof, hair, wool, and feathers are appendages. It is one of the most insoluble and stable of the proteins, and decomposes with less readiness than the proteins which build up flesh or blood, for instance. Manures prepared from horn, hoof, hair, feathers, and wool are all less active than similar manures made from

flesh and blood, and it is more necessary that they should be in a very fine state of division.

As hair and feathers are coarser, or in larger particles than wool, manures made from them are usually less active. Fine small feathers or down form a comparatively active manure, but coarse feathers, and especially the coarse pens of the feathers, only decompose very slowly in the soil. Similarly in the case of hair the activity largely depends on the fineness. Fur, or very fine hair may be quite as active as wool, while coarse bristly hair, though it may contain quite as large a percentage of nitrogen, is comparatively slow-acting.

These materials, like wool and horn, contain, if pure, about 16 per cent of nitrogen. Commercial samples, however, vary greatly in purity, and the nitrogen may be much under 16 per cent. They are often used as constituents of mixed manu.es. Coarse hair of little value is sometimes found as a constituent of low-grade mixtures.

The unit price of the nitrogen in keratin manures varies very greatly. Clean, finely ground samples of horn dust and horn shavings fetch a price per unit comparable with that obtained for the nitrogen in such forms as sulphate of ammonia and nitrate of soda. Probably they are worth it for many purposes. Good samples of shoddy also fetch a high unit price, though not so high as a standard soluble manure like sulphate of ammonia. About 9*s.* per unit of nitrogen, equal to 7*s.* 6*d.* per unit of ammonia, would represent the market value of the best class of shoddies. On the other hand, the lowest grades of shoddy can be obtained at about 5*s.* per unit of nitrogen, and sometimes, as already mentioned, wool waste in limited quantities can be obtained for a mere trifle.

Silk contains another protein called fibroin, which is similar to wool in manurial value. When pure it contains about 17 per cent of nitrogen. The waste of silk milling and refuse silk fabrics are used as manure in a similar manner to shoddy, and have a similar value.

Skin and Leather.—A certain amount of waste skin is used as manure. Some of this is mixed in flesh manures, meat guanos, and such substances. With the exception of the epidermis, which consists largely of keratin, the skin is composed of protein substances similar to those found in flesh. Untanned skin decomposes readily, and has a manurial value little inferior to that of flesh. It should be dried, and broken up finely before use. In the manufacture of leather goods there is a great deal of waste clippings and trimmings, and much waste leather is also obtained from old worn-out leather goods. Much of this is collected, dried, ground to meal, and used as manure. It is difficult to get evidence of the extent to which leather is used as manure, and samples of the ground leather are not often seen. The trade appears to be mainly a hidden one, and the leather is generally sold for manure under euphemisms such as 'nitrogenous fertilizer'. It is used in making mixed manures. Low-grade mixtures often contain it, and even in high-grade manures a little of it is sometimes found. The very properties, durability and resistance to decay, which make leather valuable for the manufacture of boots and other leather goods, render it of little use as manure. Experiments show that even when it is well ground its nitrogen has only a fraction of the value of that in meat meal or well-ground horn. In order to make it of value as manure it requires to be treated with sulphuric acid. This disintegrates it thoroughly, and makes its nitrogen much more available for plants. Ground leather contains from 5 to 8 per cent of nitrogen, equal to 6 to 9½ per cent of ammonia. It is sold in bulk at a low unit price, but when made into mixtures a price much above what it is really worth is charged for it.

Meat Meal and Dried Blood.—Much waste flesh is obtained from the carcasses of animals unfit for human food, which are treated at knackeries. Similarly, flesh fibre is obtained from works which make meat extracts, and though much of this is now used for making feeding-stuffs, part goes for manure. Meat meals are rich in nitrogen. A good sample may contain about 10 per cent of nitrogen, equal to about 12 per cent of ammonia. It also contains a little phosphate and potash; but the percentages of these are small, and practically it is for its nitrogen that it is valued. Meat meal is generally used in making mixtures, and is a highly valued manure. Some of the so-called guanos are mixtures containing dried flesh along with bone. Many high-grade mixed manures contain some meat meal.

As flesh decomposes very readily and its nitrogen rapidly becomes available for the use of crops, it forms a really valuable manure. But as the quantity is limited and in high demand for making mixtures, the unit price charged for it is always high and often excessive. Frequently the nitrogen in meat meal costs more than the nitrogen in the most active inorganic manures like nitrate of soda or sulphate of ammonia.

Blood decomposes readily, and forms a valuable quick-acting nitrogenous manure. About small slaughter-houses raw blood can often be obtained at a comparatively low price. It should be mixed with some absorbent substance to make it easy to spread. In large slaughter-houses the blood is usually collected and dried. Generally the blood is first clotted and the serum removed for the manufacture of blood albumen, and only the clot is used for making dried blood for manurial purposes. Dried blood contains about 10 per cent of nitrogen together with a little phosphate and potash. It is in large demand, and fetches a very high price per unit of nitrogen.

Makers of high-grade mixed manures like to include some nitrogenous organic substance such as flesh, fish, or blood in their mixtures, not only on account of the valuable nitrogen it contains, but on account of its effect on the mechanical condition of the mixture, which it helps to keep open in texture and friable. Therefore the demand for all such substances as meat meal and dried blood is considerable, quite apart from any demand for them for direct use. As the supply

of these substances is always limited, their price always tends to be high.

Greaves is a residue or waste obtained in the making of tallow. It contains a considerable but very variable percentage of nitrogen, which has a value similar to that of meat meal. Like meat meal, it is always in good demand and fetches a high price.

See also Fish Manures; Oilcake Manures. [J. H.]

Noctua Moths, a group of large brown or grey-coloured moths which fly by night and are especially attracted by lamps. They are the parents of the grubs commonly known as 'surface caterpillars' or (in the United States) as 'cut-worms', and which are extremely destructive of various crops, especially of the cabbage and turnip tribe, by attacking the roots and the lower parts of the plants. They are generally earthy coloured, and live for the most part underground. The principal measures to be used against them are hand-picking at night, frequent hoeing so as to turn them up to the birds, and forcing on the crop by stimulating manures. Perhaps the commonest species is the Turnip Moth, *Agrotis segetum* (see Agrotis). [C. W.]

Norfolk Horned Sheep.—The original breed of the higher lands of Norfolk, Suffolk, and Cambridge are now represented by a slender remnant in four flocks at Mangreen, Holkham, and Crown Pond in Norfolk, and Newmarket in Cambridge. The last is the largest, and numbers about thirty-five ewes which clip about 8 lb. of wool each. The breed have jet-black faces and legs, and patches of black or blue skin growing dark wool scattered over the body; and belonging to the slow-maturity class, it is very hardy and active, and free from disease, including foot-rot. It is now chiefly interesting as one of the original parents of the Suffolk breed, produced during the last decade of the 18th and the first half of the 19th centuries by mating Southdown rams with Norfolk Horned ewes. It is from the Norfolk Horned sheep that the Suffolk derived its long legs, long neck, and hard back to handle, but at the same time its wonderful wealth of lean meat seen at the end of the saddle cut, which has placed it first in order of merit in the carcass competitions at Smithfield fat-stock shows. These are all prominent characteristics of the Norfolk Horned sheep of to-day. The ewes are prolific and excellent mothers and good grazers, but being originally a mountain or heath breed they require a wide expanse of grazing. The greatest drawbacks to the sheep of this breed are wildness, and the difficulty of keeping them within bounds. The general symmetry is handsome, its carriage gay, and the mutton is excellent, resembling in flavour the best quality of Down mutton; and but for its early deficiency in wool when pitted in competition with the Merino, it would have been a much more important breed now. [R. W.]

Norfolk Rotation. See art. Rotations.

Norfolk Trotter. See Hackney Horse and Trotting Horses.

Normandy Cattle.—The cattle of the Norman breed, although found in all parts of Normandy, are chiefly confined to the two great dairying departments of Calvados and Manche. In the other Norman departments Orne, Eure, and Seine Inférieure (of which Rouen is the capital), the Norman cow is seen in comparatively small numbers, dairy farming not being conducted to so large an extent as in the first two departments named. The finest cows are found in the dairy districts of the country, where they are maintained in a state of great purity, although frequently crossed by the Shorthorn, which is believed to produce not only better beef, but a larger quantity on the primest parts. There is, however, no doubt whatever about the fact that the Norman breed is improved by the English cross; that they are better formed and grow to a larger size than the pure Norman, while they arrive at maturity for the butcher at an earlier age. On a Norman farm cows frequently are described as Cotentins, which is but a local name for one of the best types of the Norman breed. To British eyes the cow is not so handsome as she might be, owing to the brindled colour which predominates throughout the breed. The head is long, as it should be, but rather heavy; the horns are white and similar in shape to those of the Shorthorn, though slightly larger; the cow has a large muzzle which corresponds to her size; her back is fairly level; her quarters square; the udder large, often larger than it should be; while the quality of the skin is good; she carries a gentle expression, and may be distinctly regarded as a contented and useful beast. We have seen what are termed *bandes* of Norman cows in competition at French exhibitions, and which are comprised in lots of four. Useful cattle supply 5 gal. of milk daily—although we have heard of instances in which 7 to 8 gal. have been produced—and as much as from 3·5 lb. to 4·0 lb. of butter, which we have seen in particular cases sold in the Paris markets at more than 2*s.* per lb. at wholesale price. The cows are usually tethered in the field, the stakes to which they are attached being removed as occasion requires. This practice is largely owing to the want of hedges, the very utmost being made of the land owing to its exceptional quality and value, for it sometimes reaches from £100 to £200 per acre. [J. Lo.]

North Devon Cattle. See Devon Cattle.

Norway, Agriculture of. See European Agriculture.

Norway or Common Spruce (*Picea excelsa*), the only European species in the genus Picea of the Abietineæ tribe of the Coniferæ. It is an evergreen tree having solitary, spirally arranged leaves, neither divided (as in Pines) nor in tufts (as in Larch and Cedar), and its cones ripen within a year and have thin broad cone-scales becoming thinner at the edges. In Spruce the leaves are sessile, 2- or 4-sided, ranged along the upper and under sides of the twig, and each with two lateral resin ducts; whereas in Hemlock (Tsuga) the leaves are petiolated and 2-sided, and have only one resin duct running along the back of the leaf. The Common or Norway Spruce belongs to the humid hilly and mountainous tracts of Central Europe and Asia, its finest development being

attained in northern Germany and the Baltic regions. Introduced into Britain about 1548, it has never been largely cultivated, though it thrives well at an elevation of over 1000 ft. in Northumberland, and grows well in most parts of Scotland; but it is little suited for the milder climate of central and southern England. It grows to a height of over 100 ft., with a girth up to over 10 or 12 ft. With a narrow conical top and capable (in a cool, humid climate suitable to it) of enduring a large amount of side shade, it runs up in close-canopied woods with a very clean, straight bole; but when standing free and isolated it remains clothed to the ground with pendulous and thickly foliaged branches, which render it a most picturesque and ornamental tree. It does not endure overhead shade so well here as on the Continent, and in Britain the Silver Fir seems preferable for underplanting. Spruce timber is known here as 'white deal' (Scots Pine being 'red deal'), and is largely imported from the Baltic for building, scaffolding, &c.; but unless grown in very close canopy, stems become knotty and of little value. It is now, along with softwoods, the chief wood used for pulping; and if large supplies of smooth close-grown timber were anywhere obtainable in compact blocks, a pulp industry would be almost sure to spring up simultaneously. It may therefore perhaps be soon largely planted in the Scottish Highlands. It can easily be grown from seed collected after the cones ripen in autumn. The seedlings are of slower growth than Larch or Pine, and should stand two years in the seedbeds before transplanting into nursery lines for two or three years till big enough for planting out. It stands transplanting well.

[J. N.]

Notching, or **Slit-planting.** See PLANTING.

Notice to Treat. See art. LANDS CLAUSES ACTS.

November, Calendar of Farm Operations for.—

1. SOUTHERN BRITAIN

ARABLE LAND.—Mangold and swede lifting and clamping is done in the early part of the month. The land is got ready and wheat is drilled as soon as possible after being cleared of the roots. Ploughing corn stubbles occupies the teams this month. The land intended for beans and peas should be ploughed up first, and that for roots left till later. It is well to select the stiffest fields to be ploughed first. The last crop of potatoes should be pitted, also carrots, parsnips, and white turnips. In fine weather, cart dung on to the fields. Marling, liming, and claying the land may now be carried out. Threshing corn is done in this and other winter months as the grain or straw is needed, either for use or for sale. The straw that is cut into chaff for use should be mixed with salt to flavour it when piled up in the chaff bin.

In water meadows irrigation should be carried on during this month. Ditches should be cleaned out now in readiness for the winter, and at the same time the hedges can be repaired and trimmed. Land-draining can be done this month if the weather is favourable. The subsoil plough can be very advantageously used in the ploughing now. See that the water-furrows are cleaned out in the arable fields after seeding.

STOCK.—The days are getting shorter in November, and consequently the working hours of the horses are less, but they require full rations, as ploughing is heavy work. Colts are wintered in the yards, but sometimes are left out except in severe weather, when they receive coarse hay, roots, and tail oats. Milking cows are better to be let out to the pastures for a few hours daily if the weather is at all favourable.

Kohlrabi, cabbages, turnips, and swedes are fed to the cows during this month. The cabbages and kohlrabi are generally carted directly off the land. Mangolds come into use later. Pea, rice, and bean straw make splendid chaff for feeding. Bean chaff is best after being stored up for a while, as it is too sharp and hard when fresh chaffed. Oat straw and hay are fed either as hay or chaffed.

Bullocks are now all being fatted in the yards and sold off as they become mature. Young stock and stores are better to be housed in the yard at night, and get a little cake and some rough fodder to pick over. Dry cows and stores are often wintered in the fields, but there should be an open shelter available, and in bad weather they should get some rough fodder to pick over in the lee of a hedge. On arable farms the sheep are folded on cabbages, soft turnips, and kohlrabi, and, later on, on swedes. The swedes and kohlrabi are best fed sliced, as there is then less waste. They also receive an allowance of hay and cake, the latter in proportion to the time they have been fattening. Sheep on grass also receive cake, and may get hay in severe weather. Ewes that are due to lamb early are getting forward.

It is not desirable to have very young pigs in the yards at this season, as they require too much attention to be profitable. This is the best season to put sows and gilts to the boar so that they may farrow in March.

In the poultry yard the birds that are to be fattened for Christmas are being set aside to come ready in succession. The incubator may be used to hatch off early chickens. They will pay for it, and will not be much trouble if reared in a roomy, well-constructed, dry run.

[P. M'C.]

2. NORTHERN BRITAIN

If any potatoes are still undug they should receive attention at once, as there are few years in which two or three sharp nights of frost are not experienced in the last week of October or the beginning of November. At such periods the loss to undug potatoes is often enormous, and potatoes which have been subjected to even slight frost seldom keep well. If mangolds are grown they should also be stored without delay, for although they can stand a little frost without injury, they often suffer badly if unsecured at this date. Potatoes which have already been pitted should be securely covered up about the middle or end of the month. If it is desired to take out seed and to put it in boxes, this should

be done now by turning over the crop, and taking out the seed and soft potatoes before finally covering up the pits. A few inches of earth on the inside and plenty of straight straw on the outside will give much greater protection against severe frost and rain than a great thickness of earth.

Wheat sowing should be pushed on with vigour, and if possible completed as early in the month as possible. All seed wheat, no matter from what source it is obtained, should always be dressed before sowing with some substance capable of killing the spores of smut. For this purpose few substances have given such general satisfaction as sulphate of copper. If of 98-per-cent purity, from ½ lb. to ¾ lb. is quite sufficient for 4 bus. of good seed. If smutted grains are noticeable it is advisable never to use such for seed.

The turnip crop should be secured during all dry periods. If stored outside, few methods keep turnips till the end of January any better or at less expense than putting them in a large heap 3½ to 5 ft. deep, covering them on the sides with earth or straw, and with straw alone on the top. For keeping later, it is better that they be put up in small pits in the field and covered with earth, or best of all, that they be covered in by the plough. By this system two drills are usually pulled and neither topped nor tailed, but are replanted in the bottom of the drill, and the bulbs covered with a furrow of earth. The leaves and tops of the bulbs are more or less exposed, but the roots are in great part covered. If the work is carefully done, and carried out in time, the roots are better preserved during the late spring months than by any other method yet suggested. The covering up is very speedily done, but the removal of the roots later on is somewhat slow.

All manure intended for land from which hay has been removed, or pasture land which has not yet been dunged, should be attended to during intervals when other work is not pressing. In the drier parts of the country all dung in the courts or in heaps may be spread on the stubble land as opportunity occurs. If put out in heaps, the heaps should be spread without delay, as if they lie, even for a short time, all their soluble contents gravitate to the soil under the heap, where ofttimes it not only does little good, owing to being in excessive quantity, but frequently does positive harm. The better plan is to scatter it roughly direct from the carts, and later on to break it up finer and spread it more uniformly. By this method labour is not only saved, but manure is prevented from loss. All manure so spread may be allowed to lie on the surface a few weeks before being ploughed in. In districts of heavy rainfall, dung should not be spread on the flat in autumn, unless where there is a living plant, as in such circumstances the loss by filtration is often very great.

Stock of all kinds should be housed during this month, but great care should be exercised to see that they are kept freely ventilated as long as the weather remains reasonably mild, as if they are kept close and warm now, they can rarely be freely ventilated with advantage later on. In the production of winter meat and milk, we seem to have put by far too great a value on heat, and much too little on fresh air.

[J. S.]

November, Calendar of Garden Operations for.—

1. Southern Britain

Preparations for spring work must now be proceeded with; and where there is trenching to be done, November is by far the most suitable month for the work, as the soil gets settled and sweetened by exposure before it is cropped in spring. The practice of burying garden refuse as the soil is turned over should be discontinued, seeing that the eggs of insects and the spores of fungi are harboured in such material, and to place them in the soil is to a large extent affording them protection and encouragement. It is therefore better to collect all such material and burn it in a fire on the ground itself; the ashes may then be spread on the soil. If all the surface soil to a depth of 2 or 3 in. were to be skimmed off in November and burnt, it would result in a saving of labour later on, as not only would most of the insect and fungoid pests be destroyed in the fire, but practically all the seeds of weeds would be got rid of.

Work among the fruit trees during this month is time well spent. Dead and useless branches should be sawn off, and attention paid generally to the shape and safety of the trees. Should any be transplanted, dry weather ought to be selected for the work, and, in the case of large trees, after the soil has been filled in it should be thoroughly watered to settle it about the roots. Should any root-pruning be required, let it be done now. And of course the pruning of the branches generally should be seen to in this month or next. If any trees show evidences of the presence of insects such as Woolly Aphis or Scale, they should be washed with an insecticide. In the case of wall trees this washing is particularly necessary; and on all walls it may be necessary to take down the trees and thoroughly saturate the walls with a strong insecticide before replacing the trees.

Towards the end of the month it will be necessary to see to the protection of such things as endive, lettuce, celery, artichokes, broccoli, and cauliflowers. Asparagus beds should be cleared and manured; horse radish taken up and stored; sea kale lifted and placed in boxes of light soil for forcing; a few clumps of rhubarb dug up and put in a little warmth, either in a frame or under the staging of a greenhouse, for a supply of forced sticks early in the year; chicory roots should be prepared for forcing, and seeds of dwarf beans, radishes, carrots, and lettuce may be sown. If a frame is prepared by making a manure hotbed and placing on it 6 in. or so of light rich soil, it may now be filled with young cabbage lettuce set about 9 in. apart, and among them scattered the seeds of a turnip radish. Spinach also may be grown in this way. Where there are plant houses particular attention should be paid to ventilation and temperature. Chrysanthemums, abutilons, primulas, salvias, and other winter-flowering

plants will have been brought under glass, and unless they are allowed plenty of light and air they are likely to be spoilt. [W. W.]

2. Northern Britain

When the various root crops are safely secured, see that the plantings of green winter vegetables are cleaned and in order before hard frosts set in. Earth-up late celery when the soil is dry and friable; if the operation is performed when the soil is wet and sodden, do not expect the crop to last over the winter. Rather, in the event of the weather breaking and continuing wet, with little chance of the soil becoming dry enough for the purpose, use sifted ashes as the protective and blanching medium. In heavy wet soils such are preferable, especially when celery has to be kept until the spring months. Have a supply of suitable protective material handy, to cover any crop likely to suffer injury by a spell of exceptionally severe weather.

Flower borders and summer vegetable quarters must now be cleaned up. The plots or breaks to be trenched may be made the deposit for the refuse and cleanings until such time as the work of trenching takes place, when by spreading it into the bottom of the trenches it not only is got rid of, but assists materially to maintain the fertility of the soil.

All stakes and trainers, whether of wood or iron, ought to be cleaned, and stored away at once. It is a sign of bad management to see stakes and garden appliances generally, when not in use, lying about in an untidy manner.

Should hard weather set in, manure ought to be wheeled on to vacant plots in readiness for the digging or trenching of same.

When the weather is open and fine, any planting of fruit trees and bushes, roses, and deciduous plants generally, should be taken in hand first. Such work must be done early and under the best possible conditions as regards the soil, which is warmer during this month than it will be until after March. After planting, see that each subject is made secure against swaying by wind. It will repay the trouble to stake every newly planted rose or gooseberry bush in places subject to winds, until they have established themselves by a season's growth.

Where through the stress of other work the planting of bulbs has been delayed, lose no time in having it done.

In places where the soil is naturally cold and damp, some extra precautions will be necessary with many plants hardy enough to withstand ordinary winters where the soil and atmosphere are drier. While it will be better to lift some species and place them in a frame, others will withstand the climatic changes if afforded some protective covering to their crowns. Coco fibre, leaf soil, sharp sand, or clean ashes are, in the order given, excellent material for the purpose.

If any alterations are intended to be made in the way of ground work, it is advisable to have such carefully planned beforehand, and everything ready to carry out the arrangements as quickly as possible, in view of the uncertainties of the weather in winter months. Much of such work can be done when the conditions are unfavourable for ordinary garden operations.

[J. Wh.]

Nubian Goat.—This goat, of which there are at least two varieties, is met with in Nubia and Upper Egypt. The common kind is the Berber, but that most sought after, on account of its exceptional milking properties, is the Zareber, which abounds in the neighbourhood of Erythrea.

The type of this latter breed is altogether peculiar, and as regards the head is not unlike the camel. The facial line is strongly arched, with a depression at the nostrils, which lie in a kind of hollow. The muzzle is very small, the lower jaw protruding beyond the upper, like in the bulldog. The ears are of considerable length and hang down on each side of the head. The neck is slender, the body elongated, and the limbs out of proportion in length to the body. The coat is short and close and of various colours, frequently a combination of different shades of brown relieved with white.

Only three specimens of this variety of the Nubian have been known in England. One of these was a male which at one time formed part of Sanger's Circus. The other two were a pair of she-goats the property of H.M. King Edward, having been sent to the late Queen Victoria by the Duke of Connaught from the Soudan.

[H. S. H. P.]

Nuisance.—Nuisances may be divided into two main divisions—(1) Public nuisances, which affect the public as a whole; and (2) private nuisances, which affect the person or property of an individual. Most of the nuisances which fall under the definition 'public' are statutory nuisances, that is to say, arising under such Acts as the Public Health Acts, the Acts relating to Roads, Police Acts, &c. This article is confined to a consideration of private nuisances.

A nuisance, whether regarded from the point of view of the public or of an individual, may thus be defined: 'whatever is noxious or unsafe or renders life uncomfortable to the public generally or to the neighbourhood; whatever is intolerable or offensive to individuals in their dwelling-houses or inconsistent with the comforts of life'. To this may be added that a nuisance will also arise whenever substantial injury to property is caused by operations carried on in an adjoining property. Such an infringement of the rights of ownership gives rise to action to prevent the erection of what is avowedly a nuisance, and also of damages to repair the wrong already committed.

In order to constitute a nuisance material injury must be caused, either by endangering life or health, or by sensibly interfering with the comforts of life, or by causing damage to property.

(1) *Danger to Life or Health.*—If it be proved that the operations complained of constitute a real danger to life or health, this at once demonstrates that material injury is being done, and there will be no difficulty in proving the existence of a nuisance.

(2) *Discomfort to Life.*—Here the question becomes more difficult of solution, for it 'is certain that the person complaining of a nuisance

must not be too fastidious, and that he must use all reasonable means within his own premises to minimize the inconvenience of which he complains'. Moreover, in coming to a decision, the question of locality will have an important bearing, for 'the affairs of life in a dense neighbourhood cannot be carried on without mutual sacrifice of comfort, and, in all actions for discomfort, the law must regard the principle of mutual adjustment'.

(3) *Damage to Property.*—Whenever the act complained of occasions material damage to property, there will be little difficulty in establishing the existence of a nuisance. This may arise either by actual injury to, or by depreciation of, the property.

(*a*) Actual injury may be caused, as when furniture is soiled by smoke, or trees or produce destroyed by noxious gas. But in order to ground an action the damage must be real and visible; it 'must be such as can be shown by a plain witness to a plain common juryman'.

(*b*) Property may be depreciated in value by the operations complained of rendering occupation so uncomfortable as to drive away tenants. But the reason for the tenants leaving must be some real sensible discomfort which would justify the tenants themselves in objecting to the act, and not merely a sentimental or other fastidious objection. Thus it has been held that the establishment of a national school in the vicinity, though it might make letting difficult and thus depreciate the property, could not be said to be a nuisance.

Assuming, however, that a nuisance exists, it is to be noted:—

(1) That it is no answer to say that the complainer has come to the nuisance and so cannot object, for there is no room for this plea in any intelligible sense except it rest upon acquiescence or prescription.

(2) Nor is it a good answer that the defendant is not the sole cause of the nuisance.

(3) It will not avail the defendant to assert that the operations complained of are of public utility, for it has been said that in such a case, 'as in all the great dispensations and operations of nature, the interests of individuals are not only compatible with, but identical with, the interests of the public'.

(4) Nor is it a good answer to reply that the complainer is himself committing a nuisance, for this plea will fail on the ground that if the defendant is suffering by the claimant's nuisance he has an immediate remedy by counter action, and, on the other hand, if he is not suffering, he cannot plead the nuisance done by the complainer to third parties in answer to the nuisance committed by himself.

Apart, then, from grant—expressed or necessarily implied—and statutory authority by Act of Parliament, the only valid defences to an admitted or proved nuisance are acquiescence and prescription.

(1) *Acquiescence.*—The right to object to a nuisance may be lost by acquiescence, but in order to effect this the acquiescence must be brought up to an implied contract. Consequently it is only where the party having the right to stop the operations is aware of what is being done and of his right to object, that there can be said truly to be acquiescence. Moreover, implied consent will at best only bar the right to object to such a nuisance as might reasonably be expected to result from the operations acquiesced in, and any material increase in the nuisance will revive the right to object.

(2) *Prescription.*—The right to object may be lost by failing for the prescriptive period to take any action to stop the nuisance; but the extent to which the right is excluded is limited to the amount of inconvenience which can be traced back through the whole prescriptive period, and will not avail to justify any material increase in the nuisance. [D. R.]

Nursery (Garden).—This term is generally understood to apply only to trade establishments devoted to the rearing of all kinds of plants during their early stages of growth; but it is essential to the economical management of every large private garden that numbers of plants should be raised at home, and it is customary to see a piece of ground set aside for this purpose, which is designated the nursery quarters or reserve garden. It would be well were even more done in this direction in private gardens than is commonly the case; for by the exercise of a little foresight in estimating future requirements, not only might considerable savings be effected, but with an abundance of home-grown flowering shrubs, &c., at command, the garden would be more effective than formerly And if the raising of quantities of plants at home, which less energetic gardeners would purchase, is desirable in the case of the garden, how much more so is it where fruit growing is encouraged upon the estate, and where there is a considerable acreage of woodland. It is quite true that young fruit and other trees may be purchased in large quantities at almost less cost than they could be raised at home; but it must be borne in mind that a long journey generally results in a certain loss in transplanting, indeed it has been estimated that in the case of delicate species the avoidance of any delay in transplanting may result in the saving of from 20 to 50 per cent of the trees the first year. On a naturally warm soil a north aspect is to be preferred for the site of the home nursery, but if the soil is wet a south aspect is best. It is recommended that the soil should be similar to that which composes the bulk of the estate. The nursery trade in this country is of considerable extent and importance, although it suffers somewhat from the large imports from districts, such as that of Boskoop in Holland, exceptionally favourable to the work and where labour is very cheap. On the other hand, British-grown plants usually have to contend against a tariff when exported.

The last thirty years have witnessed a remarkable development in the growth of what are called market nurseries; that is to say, market gardens which contain a considerable area of glass for the cultivation of such crops as grapes, tomatoes. cucumbers, ferns, and forced bulbs.

There are now whole districts in which this business forms the principal industry, notably the Channel Islands, around Worthing, and in the Thames valley, and a number of such establishments are to be found in the vicinity of every large town. Despite a marked fall in prices due to increased competition, the business is a profitable one; but heavy losses may be sustained by those who take it up without a good practical knowledge of horticulture. Efforts have for some time past been made to compete with the Dutch bulb growers, notably in the Channel Islands and the Lincolnshire fens, but the enormous number of bulbs we import has not been notably decreased. The leading Dutch growers have agreed not to send cut flowers to this country, as by so doing they would largely destroy the more profitable trade of sending us bulbs.

[W. W.]

Nursery (Woodland). — Nurseries for woodlands, whether permanent or temporary, are profitable on any estate where extensive planting is about to be carried out. Temporary nurseries are formed on or as near as possible to the planting area, and are generally made with seedlings or young transplants that have still to stand for one or two years in the nursery lines before being planted out. Thus, say the young plants are set at 1 ft. apart (43,560 per acre), then 1 ac. of temporary nursery would supply plants enough for planting about 16 ac. at 4 ft. by 4 ft. (2722 per ac.), all the plants being lifted and planted out except those standing at 4 ft. apart (= one-sixteenth of the whole). Permanent nurseries often lie at some distance from the planting area, and cost more for soil-preparation, weeding, and tending, but are necessary if the plants needed are to be grown on the estate to secure their being thoroughly acclimatized; and for planting on a large scale, home-grown plants of good quality can thus usually be obtained at the cheapest price.

The site selected for a nursery should be open and airy, but not exposed. Damp places and hollows should be avoided, on account of frost, insects, and fungi. The W., N.W., or N. aspect is preferable to E., S.E., or S., where late and early frosts do most damage. The best soil is furnished by a well-drained, good sandy loam, favouring the development of a good root system; but it should not be in rich cultivation, else the plants grow lanky, in place of being bushy and robust for planting on rough hillsides with poor soil. The nursery should be divided into rectangular plots and beds, its size being of course regulated by the number, age, and kinds of plants needed for annual output. If only 2-year conifer seedlings are wanted, then from ½ to 1 per cent of the area to be planted annually will suffice; but if 2-year-1 and 2-year-2 transplants are needed (*i.e.* 2-year seedlings set respectively for one or two years in lines), then from 4 to 5 per cent of the annual area may be required. For a new nursery the ground should be trenched to a depth of 18 in. or more, and the soil well broken up and pulverized; and expensive weeding is reduced to a minimum if the surface soil is put at the bottom of the trench. If the soil is only 6 or 8 in. deep, it should be ploughed as deep as possible, with a skim coulter on the plough to pare off the surface layer about 2 in. deep and turn it over into the bottom of the last furrow. This makes the turf easier dealt with when the plants are being laid, though it neither prevents growth of weeds nor obviates trouble when digging with spades. Towards the end of April or early in May is soon enough to sow seeds upon seedbeds whose soil has been thoroughly pulverized at least down to one spade's depth by repeated digging and raking; and the seed should be sown when the soil is quite friable, and neither wet nor dry. It is important that the seed sown should be of good quality, as the percentage of germination varies greatly according to the locality from which the seed is obtained and the care with which it is collected. The seedbeds should not exceed 4 ft. in breadth (though 3 ft. 9 in. is preferable), so as to permit of easy weeding, without tramping and injuring the plants. The seeds of broad-leaved trees are usually sown in drills, though large seeds like acorns and chestnuts are dibbled or sown singly, while very small seeds like Birch, Alder, Elm, &c., are sown broadcast and lightly pressed down with a very slight covering of fine mould. The seeds of coniferous trees are in Britain usually sown broadcast (though usually in drills on the Continent). In sowing broadcast, after the seedbeds have been lined off to a suitable length and breadth (3 ft. 9 in. to 4 ft.), part of the surface soil is drawn with a fine iron rake to each side of the bed and a light roller is used to smooth the earth; then the seed, previously rolled in moistened red-lead powder for protection against birds, mice, and insects, is broadcast evenly over the bed, lightly covered with soil by quickly passing a fine rake over the bed, and pressed in by the roller being again lightly passed over the surface. The soil covering need only be from ¼ to ½ in. deep (according to the size of the seed), a light dry soil needing the thicker covering to prevent the seedlings getting scorched during hot dry weather. For conifers the quantity of seed required may vary (according to the ascertained germinative percentage) from about ¾ to 1 lb. for Scots Pine and Spruce, and 1 to 1½ lb. for Larch, per 100 sq. ft. of seedbed for broadcast sowing; but this may of course vary greatly with the quality of the seed. Drill sowing needs less seed per 100 sq. ft. of seedbed than broadcast sowing, and weeding is easier and cheaper; but unless carefully thinned the plants are generally lanky and have weakly developed roots, so that broadcast sowing is usually preferred for conifers in Scotland.

Most conifers should stand for two years in the seedbeds before being transplanted into the nursery lines, though 1-year seedling Larch may sometimes be transplanted if carefully handled. Transplanting for one or two years is usually needed to develop strong, sturdy plants with a good compact root system, suitable for planting out on rough ground with poor soil. In transplanting it is best to range seedlings in beds according to their size, so that all on one bed may develop about equally and be ready for sending out at the same time. And when trans-

planting, long straggling roots should be pruned back as likely to get doubled and deformed. Thus the bigger class of seedlings may be ready for putting out as 2-year-1 transplants, while the smaller may only be ready as 2-year-2. Where extra strong plants are specially wanted, they can best be obtained by transplanting annually for two or three times, to stimulate the growth of rootlets near the stem (this being a natural effort to speedily overcome the physiological disturbance caused by loss of rootlets at the extremities when transplanting). The work of transplanting seedlings into nursery lines costs about 3*d.* per 1000 (from 13,000 to 15,000 being a man's work for one day at 3*s.* 4*d.* a day), but weeding costs a good deal from time to time, and so transplants usually cost from 12*s.* to 20*s.* per 1000 to produce, according to the price of seed per lb., its germinative percentage, the cost of labour, and the amount of weeding required. This is about three to four times as much as 2-year seedlings cost; but conifer transplants are far more likely than seedlings to thrive on poor rough land. In every permanent nursery a spare plot should always be kept in hand for a year to rest and improve it. This can either be manured and put under a crop of potatoes, turnips, or vetches (or mustard, if there be any danger from wireworms), or else lucerne may be grown and dug in during autumn to decompose into mild green manure. On a sandy soil lupin is especially useful, owing to the large quantity of fixed nitrogen in its root nodules, and is there the best form of green manuring. About one-fourth of the nursery should be treated thus each year; and if direct manuring be applied at all, it is best given in the shape of good leaf mould (Beech best, if available) or well-rotted turf, &c. These mild natural manures are generally preferable to stronger artificial or chemical manures, which usually tend to produce lanky plants ill fitted for planting out on rough poor land. [J. N.]

Nurses in Plantations. See SYLVICULTURE.

Nut Bud Mite, a minute acarus which is destructive in nut plantations. See ERIOPHYES AVELLANÆ.

Nuthatch (*Sitta cæsia*). — This resident perching bird is the only British representative of its family (Sittidæ). It is fairly common in English woods, especially those of the southern counties, but very rare in Scotland and absent from Ireland. The plumage is brown above, except for white bars on the tail, and shades through reddish tints into whitish below. A hole in a tree is selected for nesting purposes, the aperture being narrowed by being plastered up with mud. The five to eight white eggs blotched with brown, are deposited upon such fragments of bark, &c., as happen to be present in the hole. The summer food of the Nuthatch consists chiefly of grubs, beetles, and other insects. During autumn and winter this is largely replaced by beech mast, hazel nuts, yew seeds, and the berries of the Portugal laurel. The species is unimportant agriculturally, but beneficial so far as it goes. [J. R. A. D.]

Nutmeg and Mace.—The former is the ruminated albumen and the latter the aril of the seed of *Myristica fragrans*, Houtt., of the Myristicaceæ. It is an evergreen diœcious tree or large bush, native of the Moluccas. The chief supply of the spice comes from Banda via Batavia, but it is cultivated also throughout the Malayan Archipelago, and to a less extent in India, Mauritius, the West Indies, and South America. The best soil is a rich friable loam with complete drainage. The climate must be hot and moist, and the situation preferably on low land well shaded. The plants are raised from fresh seed, and when 2 to 3 ft. high are transplanted to specially prepared and richly manured holes at distances of 25 to 30 ft. apart. The young trees require to be shaded, and this is best accomplished by being interplanted with bananas. When the trees flower and the sexes are ascertained, about one male may be left to every eight or ten female trees. It is a good plan to grow two seedlings in each hole, say 2 ft. apart, one to be removed on the sex being ascertained. This will generally allow of the thinning-out of the males without leaving vacant spaces. The trees begin to bear about the seventh year, and are in full bearing by the fifteenth. As many as three crops a year may be gathered. The fruits are picked up every morning as they fall from the trees, or are cut off by means of a hook. When ripe they split into two portions, and thus disclose within, the large solitary seed (or nutmeg) embraced by its scarlet mace. The shell or pericarp is removed and the mace stripped from the seed. Both mace and nuts are now dried, the nuts being placed on trays raised 10 ft. above smouldering fires. When quite dry they are rubbed with lime and carefully packed so as to prevent access of destructive insects. The mace is simply sun-dried, it then turns from scarlet to the yellow colour familiar in European commerce. The yield may be from 1500 to 2000 from each tree, or say 20 lb. prepared nutmegs and 5 lb. of mace. [G. W.]

Nutrition in Animals.—The body of an animal consists of the same elements as those present in plant tissues, but combined together in different proportions to form different substances. These elements are oxygen, hydrogen, carbon, nitrogen, sulphur, phosphorus, calcium, potassium, sodium, magnesium, iron, chlorine, and fluorine. The first four enter most largely into the composition of the tissues. Of the others, iron is an essential constituent of the blood, while carbonates, phosphates, chlorides, and fluorides of calcium, and phosphate of magnesium enter into the composition of the bones. Chlorine is also present in the hydrochloric acid of the gastric juice. The bulk of the body, however, consists of water, which is always present in large amounts, and the so-called organic compounds. The latter belong to four classes: (1) Proteins or albuminoids (*e.g.* albumin), containing oxygen, hydrogen, carbon, nitrogen, and sulphur; (2) amides (*e.g.* urea), which are also nitrogenous compounds, but of much simpler constitution than the albuminoids; (3) fats, consisting of the first three elements mentioned above; and (4) carbohydrates (*e.g.* sugar or starch), containing the same three elements as

fats, but a relatively less amount of oxygen. Neglecting the amides and carbohydrates, which are present only in comparatively small quantities, the relative proportions in which the other constituents are present in the ox, sheep, and pig in 'store' condition, as determined by Lawes and Gilbert, are as follows, the ash representing the non-combustible inorganic constituents:—

	Ox.	Sheep.	Pig.
Water	59·0	58·9	57·9
Protein	18·3	16·0	15·0
Fat	17·5	21·3	24·2
Ash	5·2	3·8	2·9

All classes of animals agree in requiring the following substances as ingredients of their food: (1) proteins; (2) fats or carbohydrates; and (3) mineral compounds, such as iron, calcium and potassium salts, &c., which enter into the composition of the bony frame or other parts of the body, but are not, strictly speaking, foods.

The food which an animal assimilates may be said to be used for two main purposes, according to the way in which we regard it: (1) to supply heat and other forms of energy, and (2) to promote growth and repair waste.

The energy of an animal's body is supplied solely by its food, the complex substances which it ingests being broken down into simpler compounds by a succession of changes which partake of the nature of oxidations or processes of slow combustion. The necessary oxygen is derived from the air, being drawn into the lungs in the act of respiration, and transferred thence to the blood, in which it is carried to all parts of the body. As a result of the oxidation processes, much of the potential energy derived from the food is liberated, and it is this liberation of energy which is the source of vital activity. In the case of the plant, on the other hand, the necessary energy is derived partly from the light of the sun; but the animal does not possess this power of synthesis, which depends on the presence of chlorophyll. The food substances absorbed in each case may be used as a source of energy either for tissue construction or for the production of heat or mechanical work.

The energy-producing power of different kinds of foods varies. It can be estimated by determining the heat of combustion of the foods. The unit of energy ordinarily employed is the amount of heat necessary to raise 1 kg. of water from 0° to 1° C., and this is called the *calorie*. Thus, 1 grm. of cane sugar is said to have an energy value of 4 calories, because if burnt in oxygen it yields sufficient heat to raise 4 kg. of water from 0° to 1° C. Such a value is the actual or physical energy value (see CALORIMETER). The physiological energy value of a foodstuff (*i.e.* the energy value to an animal) is generally less, since the substances of which it is composed are not usually completely oxidized within the body. To determine the physiological values of foods, the energy values of the animal's excretory products must be deducted from the original physical energy values. The following table gives the physical energy values of certain well-known foodstuffs, the physiological values being added in certain cases where they have been determined and found constant:—

	Physical Energy Value.	Physiological Energy Value.
Protein	4	—
Asparagine } Amides	3·4	—
Urea } Amides	2·5	—
Animal fat	9·4	9·4
Earthnut oil	8·8	8·8
Wheat gluten	5·8	4·7
Starch	4·1	3·7
Cane sugar	4	—
Grape sugar	3·7	—
Meadow hay	4·5	3·6
Oat straw	4·5	3·7
Wheat straw	4·5	3·3

The energy value of fat is therefore far higher than that of protein; but an animal cannot live on fat alone, since fat contains no nitrogen. On the other hand, an animal may live on protein alone for some time, but only on an excess of protein, since the energy value of the latter is relatively low. In a normal diet the non-protein food furnishes a good deal of the necessary energy and so replaces the protein in respect of that function. Moreover, it is found practically that an animal's food supply may be varied considerably without evil results, provided that the albuminoid ratio (that is, the ratio of protein to non-protein) is preserved within certain limits. Proteins are not stored up in the body to the same extent as fats or carbohydrates. Even if an animal which has been freed as far as possible from fats and carbohydrates by starvation is fed on a pure and abundant protein diet, proteins are not appreciably stored up, for the excretion of urea in the urine is correspondingly increased. During adult life a state of nitrogen equilibrium is normally maintained, that is to say, the amount of nitrogen excreted is equal to that assimilated in the food. On the other hand, carbohydrates and fats are much more readily stored up in the tissues, and especially in the liver. There is evidence that, under certain conditions, both carbohydrates and fats can be formed out of proteins, but the converse is of course impossible.

The value of a food depends not only on its composition but also on its digestibility, which varies for different animals. Thus ruminants (*e.g.* cows and sheep), owing largely to their capacity to 'chew the cud', are better able to digest bulky or fibrous food substances than horses or pigs.

The following tables, which represent what may be regarded as useful rations for cows, are intended to show also the relative proportions in which proteins, fats, and carbohydrates are present in certain well-known food substances:—

FOR A LARGE COW, COSTING 1s. DAILY AND YIELDING MILK

	Albuminoids.	Fats.	Carbohydrates.
12½ lb. hay	0·67	0·12	5·10
35 lb. swedes	0·45	0·03	3·71
12½ lb. straw	0·17	0·10	5·00
5 lb. cotton-seed meal	1·55	0·60	0·90
	2·84	0·85	14·71

FOR A SIMILAR COW, WHEN DRY

	Albuminoids.	Fats.	Carbohydrates.
6 lb. hay	0·33 ...	0·06 ...	2·50
25 lb. grain	0·90 ...	0·20 ...	2·70
12½ lb. straw	0·17 ...	0·10 ...	5·00
4 lb. cotton-seed meal	1·24 ...	0·48 ...	0·72
	2·64	0·84	10·92

[F. H. A. M.]

Nutrition in Plants.—The process of nutrition in the majority of plants differs very fundamentally from that in animals, in that the former manufacture the necessary food-substances from simple inorganic compounds, while animals are only able to make use of elaborated food-substances. The sources from which the ordinary green plant obtains its food supply are twofold, water and certain essential elements being derived from the soil, while the important element carbon is obtained from the carbon dioxide of the atmosphere. The hygroscopic water of the soil, as absorbed by the root hairs of the plant, contains in dilute solution a considerable number of simple inorganic compounds, and, as has been shown by an analysis of the ash of diverse plants, quite a noticeable amount of most of these compounds is taken up. Thus the ash (*i.e.* that part which is left after incinerating the plant) in most cases contains the elements chlorine, sulphur, phosphorus, silicon, potassium, sodium, calcium, magnesium, iron, aluminium, and manganese, which are absorbed in the form of nitrates, sulphates, phosphates, chlorides, &c. The water containing these substances in solution diffuses into the root-hairs by a process of osmosis, and in the same way passes on to the vascular system in the centre of the root, through which it travels upwards into the stem and leaves. Owing to the dilute nature of this solution, far more water has as a rule to be absorbed than is actually required as such, in order that the requisite amount of inorganic substance may reach the cells of the leaf. As a consequence the leaves are continually occupied in giving off the excess of water in the form of vapour, this process being known as transpiration. Large quantities of inorganic substances are thus filtered off in the leaves, and many of these play a very important part in the nutritive processes. By the method of water-culture it has been found that a certain number of the elements brought up from the soil are absolutely essential for the well-being of the plant, and that if one of them is absent normal growth and development is impossible; these essential elements are potassium, calcium, magnesium, sulphur, phosphorus, and iron, and to these we must add the elements nitrogen (which is derived from the soil, although not present in the ash), hydrogen, and oxygen, the last two, of course, being supplied in the shape of water. It is quite unnecessary for carbon to be present in the culture fluid, but it is absolutely essential that it should be supplied in the shape of carbon dioxide in the surrounding atmosphere; on the other hand, plants can make no use of atmospheric nitrogen (except certain forms of bacteria). The carbon dioxide of the air, which diffuses into the intercellular spaces of the leaves by way of the stomata and so gradually passes into the assimilating cells, is during the daytime employed in the building up of organic substance. This process, which is known as carbon dioxide assimilation or photosynthesis, only goes on in the presence of light and in the green chlorophyll-containing parts of the plant, which therefore have to supply all the non-green organs with organic substance. The carbon dioxide interacts with the water brought up from the roots to form a simple carbohydrate according to the equation:

$$CO_2 + H_2O = CH_2O + O_2,$$

so that the volume of oxygen given off is equal to that of the carbon dioxide absorbed. A large amount of energy is required for such a chemical process, and this is in all probability derived from the red and yellow rays of the sunlight, which, as shown by its spectrum, are absorbed by the chlorophyll; for this reason assimilation only goes on in the presence of light and chlorophyll. Since the latter is only formed in the presence of light of a certain intensity and when iron is supplied to the plant, these are also necessary conditions for the assimilatory process. Temperature likewise has an important bearing on the assimilatory process, for the latter does not take place below a certain temperature, and increases in rapidity with rise of temperature up to a certain limit. The first visible product of photosynthesis is either starch ($C_6H_{10}O_5$) or a soluble sugar of the nature of glucose ($C_6H_{12}O_6$). The prevalent view is that formaldehyde (CH_2O) is first formed from the carbon dioxide and water, and that this then undergoes polymerization to form more complicated carbohydrates. The latter are in part transferred in a soluble form (mostly as glucose) to various parts of the plant, where they are used in the formation of new tissue elements, as reserve materials, &c., but a considerable proportion of them undergoes further elaboration to form proteids or albuminous substances. It seems that the latter can be produced in all the different parts of the plant, although the leaves are certainly the chief centres. Apart from the three elements present in carbohydrates, proteids also contain the elements nitrogen and sulphur (sometimes also phosphorus); these can only be acquired by the plant if supplied in the form of nitrates (or ammonium compounds, which are, however, often less suitable), sulphates, and phosphates from the soil, and a plant is naturally incapable of further existence if these compounds are lacking. The elements potassium, magnesium, calcium, and iron, however, also play some very important, though little understood, part in the synthesis of proteids, since the latter process cannot go on unless these elements are available in a suitable form. Very little is known as to the method of building up of proteids from carbohydrates, nitrates, and sulphates, but it seems very probable that amides (such as asparagin, leucin, &c.) are intermediate products, although their composition is very simple, as compared with the marvellous complexity of the proteid

molecule. The elaborated food-substances, be they carbohydrates or proteids, travel to the different parts of the plant by way of the phloem, the sieve tubes of the latter probably being the most important conducting elements.

There are a considerable number of plants (Fungi and a few Phanerogams) in which the chlorophyll, essential for photosynthesis, is lacking, and all of these can only use elaborated food-substances; these they obtain either by preying on other living organisms (parasites, such as the dodder, the ergot, and the vegetable caterpillar) or by absorbing the products of decay of plant and animal bodies (saprophytes, such as the bird's-nest orchid and many mushrooms). They are connected with the typical green plant by the so-called semi-parasites (mistletoe, yellow rattle, &c.), which, although possessing chlorophyll, derive a certain amount of food-substances from a host plant. The method of nutrition of the so-called insectivorous plants is also analogous, for they likewise have green leaves, and only supplement the ordinary mode of nutrition by digesting the bodies of insects, which are entrapped by various contrivances. Finally, certain plants are capable of special methods of nutrition by virtue of their living in symbiosis with other organisms, the best example being that of the leguminous plant, in which the root tubercles contain a bacterial form capable of utilizing the free nitrogen of the atmosphere. [F. E. F.]

Nut Sawfly, a small shiny-black fly about ⅓ in. long, whose larvæ prey on cob and filbert leaves, and also on hazel nuts, osier, aspen, &c. See CRŒSUS SEPTENTRIONALIS.

Nut Weevil, a weevil whose grubs are frequently found in hazel and filbert nuts. See BALANINUS.

Nymphæa (Water Lily), a genus comprising about a score of species of both hardy and tender water plants (nat. ord. Nymphæaceæ) with fleshy or tuberous rootstocks, large, floating, heart-shaped leaves, and conspicuous white, blue, yellow, or red flowers, some of them being scented. They are very widely distributed, the familiar *N. alba* being a native species. That these plants have lately grown so in vogue is to a great extent due to the production of numerous hybrids of robust habit with pretty coloured flowers, the earliest and many of the finest of these being originated by a French grower, M. Latour Marliac. Hardy Nymphæas are of easy cultivation. They grow best in soft, shallow water, with full exposure to sunshine, and shelter from high winds. They are often grown in cement tanks specially made for the purpose, or even in sunken tubs. It is best to plant the tubers in large rough baskets filled with a compost of turfy loam, rough sand, and decomposed manure, sunk 6 in. or 1 ft. below the surface of the water, March being the most suitable time. Isolated plants or small groups will produce finer flowers than a large mass, and on a muddy bottom the stronger-growing sorts will increase so much that it is well now and then to keep them within bounds. The following are a selection of the best hardy Nymphæas: *N. alba* and vars. *candidissima* and *rosea*; *N. Frœbelli*, sweet-scented crimson-purple flowers; *N. Gladstonei*, white fragrant flowers; *N. Leydekeri*, a small-growing hybrid with pale-rose flowers, and varieties with variously coloured flowers; *N. lucida*, large vermilion-red flowers; *N. Marliacea-albida* and others of this group (they are very robust, and require to be divided and replanted every three or four years); *N. odorata*, the sweet-scented North American water lily, and its varieties; *N.* Wm. Doogue, large clear shell-pink coloured flowers; and *N.* Wm. Falconer, large ruby-crimson flowers with orange-yellow anthers. The tender species which are grown under glass require full exposure to sunshine. *N. amazonum*, fragrant yellowish-white flowers; *N. devoniensis*, bright-rose flowers; *N. Lotus*, the Egyptian Lotus, with large white or red flowers; and *N. stellata*, the blue African water lily, and its varieties, are all excellent greenhouse kinds. Nymphæas may be propagated by seeds. [W. W.]

O

Oak (Quercus) is a genus of the Fagaceæ family (syn. Cupuliferæ) of the nat. ord. Amentaceæ or catkin-bearers. As in the two other British genera in this family (Beech, Sweet Chestnut), the fruits are surrounded by a cupule formed of aggregated bracts; but in the Oak the flowers are either single, or in clusters in the axil of the leaves, or in loose axillary spikes, and the cupule surrounding each flower becomes hard and cup-shaped, and surrounds from below a nut (acorn) having a circular cross section. There are nearly 300 known species of Oak indigenous to the northern hemisphere; but only two of these, the Pedunculate Oak (*Q. pedunculata*), prevalent in England, and the Sessile or Durmast Oak (*Q. sessiliflora*), prevalent in Scotland and Wales, are indigenous to Britain, and are often included as mere sub-species of the Common Oak (*Q. Robur*). In the Pedunculate Oak the winter buds are short, thick, and blunt, the leaf-stalks short, the leaves crinkled and heart-shaped at base, and the flowers and fruits are on long stalks; while in the Sessile Oak the buds are longer and more pointed, the leaf-stalks rather long, the leaves less crinkled and more wedge-shaped at base, and the flowers and fruits sessile. But with regard to buds and foliage such differences are far less constant than the characteristics of their stalked and sessile flowers and fruits. As regards their habit of growth and sylvicultural characteristics they exhibit distinct differences, for the Pedunculate Oak is a shorter-stemmed, larger-limbed, and more branching kind of tree than the Sessile Oak, which forms a longer, straighter, and less branching bole. The Sessile

Oak is better adapted for steep hillsides; and in coppices it throws out straighter shoots than the Pedunculate Oak, and yields thicker bark containing a larger amount of tannin.

For hedgerow timber the Sessile Oak is the better tree owing to its more upright and less spreading habit of growth. But the Pedunculate Oak pollards better, and it is probably due to this that nearly all of the largest-girthing oak trees in Britain are of this species. It has also been observed that the Sessile Oak is hardly at all attacked by the leaf-roller moth (*Tortrix viridana*), which often does much damage to oak trees in England. Hence for planting the Sessile Oak deserves the preference, as the timber it yields is, while somewhat softer and easier to work, practically equal in quality to that of the other species (sp. gr. 0·76), although the Pedunculate Oak was the better for providing the strong limbs and the curved timber formerly needed for shipbuilding. British Oak timber is superior to that of any foreign species. It is the best and most durable of our hardwoods, and is largely used for furniture, ship- and bridge-building, wagon-making, railway sleepers, &c., while poles and branchwood are used as wheel spokes and pitwood. Both of these British Oaks are light-demanding trees having a deep tap-root and a strong branching root-system; and they grow best on a clayey or loamy soil, though thriving also on a good light and sandy soil that is deep and moist. It is usually on deep, heavy clay that the finest timber is found. For growing Oak with profit, land of fairly good quality is needed, since both the rate of growth and the quality of the timber depend greatly upon the soil and the situation. As an ornament in parks it surpasses all our other trees in longevity and in power of resisting storms.

The chief exotic species of Oak grown for ornament in parks include the evergreen Holm (*Q. Ilex*), White (*Q. alba*), Red (*Q. rubra*), Scarlet (*Q. coccinea*), and Turkey or Moss-cupped (*Q. Cerris*), a Hungarian variety of which retains its foliage almost right through the winter.

Owing to its demand for light, and its need of room for lateral expansion after having passed the pole-wood stage of growth and reached nearly its full growth in height, the Oak requires to be either grown along with the shade-enduring, soil-protecting Beech, or else it has to be thinned (if necessary) and underplanted to protect the soil against sun and wind. The modern Continental system of growing oak consists in either forming pure woods on good, deep, fresh soil, or of mixing it with other hardwoods (and preferably Beech), and then at about 70 to 80 years of age cutting out these other kinds and letting them shoot from the stool, or else sowing or planting Beech or Hornbeam, to form an underwood. But on the Continent such an underwood is always saleable locally as fuel, whereas in Britain underplanting with Beech might usually prove unprofitable. Treated under the Continental system, with occasional thinnings every ten to twenty years as required from about 70 or 80 years onwards, the Oak trees reach their maturity at about 140 to 160 years of age, when the soil is prepared in strips or patches to receive the acorns shed from the trees and effect natural regeneration, or else the whole area is dibbled with acorns. When the seedlings appear, the old trees have to be soon cut and removed, as the young crop is impatient of shade; and blanks can then be filled by planting more young Oak, or other kinds of trees. For raising Oak in nurseries, acorns should be carefully selected in autumn from well-grown middle-aged trees and sown at once (after being moistened and rolled in red-lead powder to protect them from vermin), or else stored through the winter in a dry airy place till wanted for sowing in spring, and in each case they require a covering of about 1 to 1½ in. of fine mould. One pound contains about 125 pedunculate or 150 sessile acorns, giving respectively about 75 to 90 seedlings, which come up in about four to six weeks after sowing in spring. Seedlings can be put into the nursery lines when one or two years old, and not closer than 4 to 6 by 10 or 12 in. apart. Where small plants are wanted, they can be used at 3 or 4 years of age; but if needed of 4 to 6 ft. high, they have to be retransplanted for other two years. Pitting at 4 by 4 ft. is the usual way of planting Oak. [J. N.]

Oak.—Parasitic Fungi.—

Wood Rot.—Much damage is done to growing timber by fungi of the Polyporus family; the fungus filaments live in the wood and destroy it, while the spores are shed from sporophores which coat the bark as thick crusts or project from it like brackets (see Fungi). The following are common on Oak: *Stereum frustulosum* gives off spores from greyish-brown crusts closely adhering to the bark, and broken up by numerous cracks; the diseased timber, known as 'partridge wood', has a dark-brown colour, broken in places by white blotches or hollow cavities. *Stereum hirsutum* has its sporophores at first crust-like, but later hanging from the bark as thin flaps with wavy margins and a dirty yellow or grey velvety upper surface; it produces a red rot marked with white or yellow stripes. *Polyporus sulphureus*, common on many trees besides Oak, has large, soft, flat orange or yellow sporophores, which die soon after shedding the spores; the diseased wood shows a red rot interspersed with sheets of white felted mycelium. The wellknown Beefsteak fungus (*Fistulina hepatica*) also causes a red rot. *Polyporus dryadeus* has thick, hoof-like, annual sporophores, brown and rough, and often dripping with exuded moisture; it produces a mixed red and white rot. *Polyporus igniarius* has a hard dry grey or brown sporophore resembling the tinder fungus; the wood shows by a white rot.

Treatment.—The Polypores attack the tree through broken branches or other wounds, and spread from a branch downwards into the bole. Decaying branches should be cut off low down as soon as possible, and the cut surface well painted with tar, preferably in the autumn. The same dressing should also be applied when any branch is cut off. In the case of plantations, diseased trees can be removed entirely during thinning.

Slime Flux.—A white foamy fluid oozes from

the bark, and may cause much damage; if seen early it can be cut out and dressed with tar.

Oak Canker occurs on young trees, the bark becoming brown and peeling off, the wood being exposed dries up. This damage has been traced to a fungus (*Aglaospora taleola*), which enters by wounds. Removal of all diseased trees is recommended. Another form of canker occurs, caused by *Nectria* (see Apple — Parasitic Fungi).

Seedling Oak Disease. — This attacks the roots of oaks one to three years old, and is recognized by numerous fungus filaments enveloping the root; these form dark strands which penetrate the soil to adjoining trees. The fungus is *Rosellinia quercina*, and during summer it produces conidia and ascus-fruits. *Treatment.*—Remove healthy seedlings to a new plot, or, in the case of large beds, isolate infected portions by surrounding with a deep trench, and destroy all diseased seedlings. The same soil should not be used again for raising oaks. For other seedling diseases see Beech—Parasitic Fungi.

[w. g. s.]

Oak Bark. See arts. Barking; Coppice.

Oak Box Beetle, a small brick-red weevil which occasionally destroys the leaves of Oak and Sweet Chestnut. See Attelabus.

Oak Coppices. See Coppice.

Oak Galls are caused by the larvæ of *Cynips kollari*. See the article under this title.

Oat Beetle, the parent of a slug-like larva which eats away the surfaces of oat leaves. See Lema melanopa.

Oat Bruiser. See the art. Bruiser for a description of this appliance.

Oat Grass.—Two varieties of the Oat Grass are commonly met with—the Tall Oat Grass or French Rye Grass, and the Bulbous Oat Grass or Pearl Grass. Both of these are described in the art. Arrhenatherum.

Oatmeal. See Oats, Products of.

Oats.—The oat belongs to the monocotyledon class of plants, to the nat. ord. Gramineæ or Grasses, and to the genus Avena. Only certain species of this genus are considered here, namely those which are of annual duration and which are cultivated for their grains: such are called *cereal oats*. Other species of oat, such as Golden Oat Grass and False Oat Grass, are excluded, for they are perennials having nothing to do with grain production. The species of cereal oats in cultivation are:—

1. Common Oat (*Avena sativa*), with a loose ear bearing whorls, or rather half whorls, of branches spread all round the axis, thus forming an open bell ear. Each spikelet bears two perfect flowers, and, when ripe, two piles or grains, each grain with a kernel enclosed in its own special cover or husk of pales. The colour of this husk gives the name to whole groups of varieties, such as White Oats, Yellow Oats, Grey Oats, Red Oats, and Black Oats. Cultivation affects the contents of the spikelet, rendering it more prolific or less prolific than normal; thus, improved varieties such as Banner and Thousand Dollar can produce three grains per spikelet, whereas deteriorated Potato Oats and Sandy Oats produce but one grain per spikelet. There is never more than one awn per spikelet in this species, and this awn always belongs to the external grain.

2. Tartarian Oat (*Avena orientalis*), with a compact ear bearing whorls of branches slightly grown together at the base, accordingly not spread horizontally round the axis but ascending and confined to one side, forming a one-sided or unilateral ear. White Tartarian has the one-sided ear, but when the environment is unsuitable, the branches cease to grow together at the base, and thus there are all sorts of gradation between the one-sided White Tartarian and the open bell-eared form. Normally, the spikelet produces two grains, but improvement raises the number to three, and deterioration reduces to one. The grain cover or husk of pales gives the name to whole groups of varieties, such as Black Tartarian, White Tartarian, and Yellow Tartarian Oats. The varieties of this species, like those of Common Oat, never bear more than one awn per spikelet.

3. Naked Oat or Chinese Oat (*Avena nuda*), bearing three, four, five, or more flowers per spikelet, and a corresponding number of grains. The other important peculiarity is that the husk of the grain opens as in wheat, and allows the groat or kernel (*caryopsis*) to go free from the pile which bore it. This species is not cultivated in Britain and not in temperate climates; with us, Chinese Oat is only a curiosity, and very soon becomes deteriorated.

4. Short Oat, Shetland Oat, or Grey Oat (*Avena brevis*), is distinguished from all the other cereal oats by having *two awns per spikelet*, one awn for the lower pile, and a second for the upper pile of the spikelet. The husk is grey, excessively thin, and contains a very small kernel. This species has gone out of cultivation except in outlying districts such as Shetland and some of the western isles of Scotland.

Wild Oat (*Avena fatua*, *Avena strigosa*, and *Avena sterilis*) is a worthless annual which often occurs as a weed in the corn crop. The grain whether lower or upper is always awned and always very slender; the lower valve of the husk ends in a long split point, each prong lengthened out into an awn (in *Avena strigosa*), or this valve bears long brown or black hairs (as in *Avena fatua*), or sometimes long white hairs (as in *Avena sterilis*). In the growing crop, *Avena fatua* is easily recognized, for it grows fast and stands a foot or so higher than the good corn around; the 'Greys' (*Avena brevis*), as well as Wild Oats in general, are marked by the two awns per spikelet—not one awn.

During recent years, the number of varieties of oat cultivated in Britain has increased considerably by importations from America, from Australia, New Zealand, and from the continent of Europe. Besides, selectors and hybridizers have been and still are at work producing improved and new sorts. [a. n. m'a.]

The oat crop is at present, in respect of acreage and of total value, the most important of the cereal crops grown in the United Kingdom. In England alone its acreage exceeds considerably that under wheat, and still more that under barley,

while in Wales the oat acreage amounts to more than that of wheat and barley together; and in Scotland the latter two crops occupy less than one-third of the acreage under oats (see OATS, STATISTICS OF). The origin of the oat is unknown, but De Candolle considers that all the oat varieties have probably been derived from a single prehistoric form of eastern temperate Europe or of Tartary. The oat is essentially a crop of the northern temperate regions of the globe. More than one-half of the oats of the world are produced in Europe, over one-fourth in North America, and the remainder in Asia, Australasia, South America, and to a much less extent in Southern Africa. The production in North America is chiefly in the northern division of the United States, but it is now almost equal in Canada, where the cultivation of the oat is extending also very rapidly. In Europe more than half the total production of oats is from Russia, while the crop is also of the greatest importance in Norway, Sweden, Germany, and the United Kingdom. In the southern countries of Europe below the isotherm of Paris the oat is little grown except in mountainous districts, and its cultivation cannot be successfully followed in hot countries, or even in the warmer parts of the temperate zones.

The oat is a very hardy and robust plant. It stands cold and wet better than any other cereal. It has the capacity of ripening at a low temperature, and a long cool season favours its development. In hot countries the grain tends to become thick in the husk and thin and light in the kernel, while the straw is also innutritious. When the soil is sufficiently moist the oat does well in a dry climate, but where the soil is dry a moist climate is essential. Where both soil and climate are dry the oat yields badly both in grain and in straw; where both are moist the crop yields abundant and more nutritive straw, but a lower proportion of grain. Hence along the moist western seaboard of Britain the oat yields more largely in straw, while along the drier eastern coast the grain yield is higher and of superior weight and quality. The highest yields in Britain are from the moist fenlands of Cambridge, where the climate is comparatively dry. The varieties of oats which have hitherto been chiefly cultivated in the moist climates of Ireland and Scotland are also inferior as grain producers to the varieties cultivated in warmer and drier climes, and the immense yields sometimes obtained in the centre of Canada are all grown under a warmer summer temperature and a smaller rainfall.

Abundance of soil moisture is, however, essential to the proper development of the oat crop, and it is specially necessary that the supply of moisture should continue right on till near the close of the ripening period. A deficiency in moisture injures the oat more than either wheat or barley, and the cultivation of the latter crops is to be preferred in all districts liable to suffer from drought. On light dry soils the oat cannot be cultivated successfully unless under an abundant and continuous rainfall. Neither does it succeed on wet undrained soils sodden and soured by excess of stagnant water. But if the supply of moisture be right, the crop will grow better on thin and on poor soils and on soils overcharged with iron than any other cereal. The dry chalk soils and the very stiff cold clays are perhaps the least suitable. The oat is much favoured by abundant nitrogen in the soil, yet it will give a crop on soils so deficient in nitrogen as to be incapable of producing crops either of wheat or barley. No cereal does so well on peaty and high-lying moorland soils, or on decaying turf, or on land newly drained and broken up, and on no kind of soil does the crop altogether fail. It does specially well on land rich in organic matter, and flourishes on deep black loams and alluviums. The presence of some clay is beneficial. The finest crops of oats alike in weight and quality are grown on clay loams, and seed from clays or clay loams is considered superior to that from lighter soils. In England the oat is cultivated with least success in the south and south-eastern counties, where the climate is dry, and where the light sandy and chalky soils as well as the clays resting on the London, Gault, and other formations are unfavourable.

Of the date of the introduction of the oat into Britain there is no record, and no accounts have been preserved of the origin or discovery of varieties which were at one time extensively cultivated. For several centuries perhaps the most extensively grown variety was the Naked Oat, also known as Pilcorn or Piley, or the skinless oat, which is now hardly known in Britain. In the first half of the 18th century it was a widely grown oat in Wales, Scotland, and the north of England, where it was preferred in spite of its liability to shed grain, because of its hardiness and its power of yielding well on wet peaty soils, and especially on soils too poor to grow any other crop. It was frequently the last crop grown after an exhausting series of wheat crops before the land was allowed to pass entirely out of cultivation for a period of 'rest', and in Cornwall it was therefore called the 'farewell' crop. In the south of England other varieties of white oats were more largely grown, of which the best known during the 18th century was perhaps the Poland, which appears to have been introduced into Britain about the beginning of that century, and which is still grown in districts of Wales and elsewhere where yellow oats are in favour. Varieties of Red or Brown Oats were grown largely in the midland counties, and were considered to be specially adapted for the stiff clay soils and to form the best horse feed. Black Oats competed with the Naked Oat in the poorer and moister soils of the northern parts of the kingdom, and before the commencement of the 19th century the place of the Naked Oat on the poorer soils had been largely taken by dun or brown, and black varieties. None of the varieties grown seem to have been very productive, for in the middle of the 18th century 25 to 30 bus. was considered an average yield, and 48 bus. a specially large crop of White Oats. In 1824 Professor Low of Edinburgh gave 30 bus. as an average and 60 as a large crop for Scotland.

It appears to have been in the latter half of the 18th century that the Black and White Tar-

tarian Oats were first brought from the East into Europe and introduced into England. The White Tartarian has continued to be cultivated to a limited degree in England, but has never attained to such favour as in France. The Black Tartarian, on the other hand, gradually extended its area of cultivation in England, and was introduced into Scotland early in the 19th century, where it rapidly became popular. It quickly drove the older Black Oats out of cultivation on account of its superior productiveness. It is now grown in all parts of the United Kingdom, and more especially on the moist peaty soils of Ireland, for which it has a special adaptation.

In the year 1788 there was accidentally discovered a variety which during the whole of the 19th century formed perhaps the most extensively cultivated and the most important of British varieties. This was the Potato Oat, so called because it was discovered growing in a potato field in Cumberland. It has been suggested that it may have been the produce of a grain of seed of a South European variety accidentally conveyed in straw-packing into one of the shipping ports of Cumberland, and from thence to a farm. This oat rapidly sprang into favour, and during the first half of the new century became the favourite oat on all good soils in the north of England and in the south of Scotland, displacing the Blainslie, which had previously been the favourite oat of these districts, as well as other varieties. It continued to hold the position of premier Scotch oat right to the commencement of the 20th century, and its cultivation was also extensive on the best soils of Ireland and in other parts of the United Kingdom.

Among varieties adapted for somewhat poorer soils, special reference may be made to the Sandy, which was discovered in 1824 growing on the farm of Miltoun of Noth, in the parish of Rhynie, Aberdeenshire, on a bank formed from the cleanings of a ditch in the preceding winter. It was first noticed by a herd boy, Alexander (Scottice, Sandy) Thomson, whence its name Sandy's oat, which has become contracted in common use into Sandy oat. This oat was propagated by the farmer, a Mr. Pirie, and its cultivation quickly extended over Scotland and other parts of the United Kingdom on land too poor or exposed for the successful growth of the Potato oat. Numerous other varieties were grown at the same time, most of which more or less closely resembled the Sandy and the Potato, or were selections from the latter oat. Lawson in his Vegetable Products of Scotland (1852) gives a list of thirty-eight cultivated varieties, of which twelve were named as prominent, and given in order of cultivation in Scotland as follows: Potato, Hopetoun, Sandy, Early Angus, Late Angus, Grey Angus, Blainslie, Berlie, Dun, Friesland, Black Tartarian, and Barbachlaw. Of the remaining twenty-six varieties named, all have now disappeared except the Kildrummy, an oat still grown in the north of Aberdeenshire and on other poor soils; the Old Poland, universally known as Tam Finlay, from the name of an enthusiastic devotee, and still first favourite on stiff clay soils in parts of Ayr, Lanark, and Stirling shires; and the Friesland oat, still to be met with on the carse lands in Scotland, and also in Berkshire and some neighbouring counties. Of the twelve more prominent varieties named by Lawson, the Early Angus was the favourite oat of the northern counties of Scotland, while the Blainslie was chiefly grown in the south-eastern counties. The Hopetoun, which was a selection from the Potato oat made by Shireff of Mungoswells, East Lothian, fell out of favour in a few years, but the Black Tartarian on the other hand increased in popularity and was most extensively grown in Ireland, Wales, and certain parts of England, where the Potato oat also occupied considerable areas, up till the end of the century, along with the Poland, White Tartarian, and others. In 1864 some further selections from the Potato oat were made by Shireff, of which the most successful was the Early Fellow, which still retains some popularity in Scotland. Other selections from the Potato which have proved successful were the Longhoughton and the Hamilton. The latter variety was introduced by a Mr. John Hamilton of the farm of Whitehill, Stepps, near Glasgow, in the third quarter of the century, and being somewhat hardier and more vigorous than the Potato, is now widely grown on soils of secondary quality over the west and the north of Scotland.

A new era in oat growing commenced in Britain in 1892 when Mr. John Garton, of Garton Bros., who for twelve years from 1880 had been devoting himself to the production of new varieties obtained by crossing, placed the first of his oat varieties on the market. This was the Abundance, a cross of the White August and the White Swedish. It is now the most extensively cultivated oat in England, and is also largely grown in other parts of the United Kingdom. Another Garton oat, the Waverley, is in great favour in Scotland and in parts of Ireland, and these and other varieties introduced by the same firm have in great measure displaced the older varieties. Other new varieties introduced by the same breeders are the Tartar King and the Storm King, noted for their stiff straw and their earliness, which makes them very suitable for late districts, but having very thick husks; the Yielder, introduced in 1908; the Goldfinder, a yellow oat introduced in 1902; and the Excelsior, Rival, and Bountiful, all black oats introduced respectively in 1902, 1906, and 1908. In 1899 also the present writer commenced a series of trials of oats on the West of Scotland Experiment Station, and for this purpose obtained from the Central Experiment Station, Ottawa, Canada, and also from the Continent and from home producers, seed of about 160 different varieties. These experiments led to the introduction into general cultivation of the Banner oat, and subsequently of the Wide Awake, Mounted Police, and Beseler's Prolific. The Banner and the Wide Awake have long been known in the United States as among the most productive varieties. The Mounted Police was the name given by Dr. Saunders, of the Central Experiment Station, Ottawa, to a sample of seed of unknown origin

sent in from one of the mounted police stations in the west of Canada; but it was subsequently discarded from the list of varieties grown at Ottawa, and is no longer to be obtained in Canada under that name. In Scotland it has proved to be one of the most productive varieties cultivated. Beseler's Prolific, so renamed by the writer, was obtained in 1901 from Otto Beseler, a German seedsman in southern Hanover. It is known in Germany as Beseler's No. II, and has been formally reported on by some of the German experiment stations. Seed from the West of Scotland station sent to Professor Middleton of the Agricultural Department of the Cambridge University led to the introduction by him into cultivation of another American oat, the Thousand Dollar, which is now also largely grown in England.

The oat possesses a considerable power of adaptation to both soil and climate, and hence numerous varieties, differing from each other in greater or less degree, have in course of time been produced, each of which is probably specially adapted to the conditions prevailing in some particular district. The varieties differ from each other in the length and strength of the straw, in earliness or lateness of ripening, in their capacity for tillering, in their liability to shed seeds readily when ripe, in their suitableness for certain kinds of soils, in their productiveness, in the size, shape, and colour of their grains or seeds, and in the relative contents of the grain in kernel and husk. Numerous attempts at classification have been made, based chiefly on the characteristics of the grain. An old and simple classification (Dictionary of Husbandry, 1769) was that in which the oat varieties were divided by the colour of the grain into (1) white, (2) black, (3) brown or red, while the (4) Naked Oat was placed in a separate class. In later classifications of British oats the Naked and the red varieties have been dropped out of sight; and in Morton's Cyclopedia (1855) oats were classified as white, black, and grey or dun, and the white varieties were further subdivided according to their habit of growth into 'early' and 'late'. Another classification according to the form of the grain divided oats into the two great classes 'short' and 'long', the former comprising the varieties yielding short plump grains without awns, and the latter the longer and thinner grains which tend to produce awns or beards. A more exact classification based on the same characteristic was that of A. A. Wilson, of Kinmundy, Aberdeenshire, who divided the varieties cultivated in Britain in the 19th century into (1) *Oviform*, which comprised the shortest and plumpest grained oats; (2) *Coniform*, which included grains of intermediate length; and (3) *Fusiform*, which included the longest and thinnest grained oats. Another classification based on the form of the ear divides oats into (1) Spreading or Open-headed, which comprises the varieties in which the panicles spread out uniformly on all sides of the rachis; and (2) Sided or Closed 'Mane' or 'Banner', in which, as in the Black Tartarian, the panicles are all on one side of the rachis. None of these classifications are of much practical utility, because they group together, on account of some botanical feature of resemblance, numerous varieties which differ widely from each other in the chief characteristics on which their agricultural value mainly depends. From the farmer's point of view the agricultural characters are, however, of primary importance, and the most important of these characters are the relative capabilities of the varieties in yielding grain and straw, the two products for which the oat crop is grown. A simple classification based on the relative yields in grain and straw of the varieties can be made, and this classification possesses the greater practical value, because associated with these characteristics are invariably found adaptations to particular kinds of soil and climate. In the following classification the varieties are arranged into three divisions: (1) *Grain Producers*, (2) *Intermediate Grain and Straw Producers*, (3) *Straw Producers*.

The Grain Producers comprise all the varieties in which the grain forms a relatively high proportion of the total yield. The exact proportion varies with the soil, the season, and the variety, but in the West of Scotland experiments it has been found that the grain generally constitutes from 38 to 43 per cent of the total yield, and the straw about 57 to 62 per cent. In a drier climate less favourable to the growth of straw, the proportion of grain might be as much as 50 per cent. The total weight of crop produced is less than in either of the other divisions; but as the varieties of this class yield both relatively and absolutely a greater weight of grain, their total value when grown under conditions suitable for them is greater than that of the varieties included in either of the other divisions. In this class are comprised all the recently introduced new varieties and most of the foreign varieties that have been introduced into this country. With the exception of the Black Tartarian, none of the older varieties cultivated in Britain, nor any of the well-known Scotch varieties, belong to this class. It consists wholly of the new varieties and of varieties grown in America and on the Continents of Europe and Asia, which were quite unknown in Britain till they were introduced for purposes of experiment. Their adaptation to the requirements of British farming and their superiority in value, under suitable conditions of cultivation, have now, however, been established by numerous experiments carried out by the agricultural colleges, and by the confirmation these have received in the experience of farmers. They are, however, only adapted for growth on good soils, such as rich loams and deep alluviums, on which the best grain producers of the older varieties, such as the Potato oat, had previously been grown, and on all land capable of yielding not less than 60 bus. grain per acre they are more productive and more profitable as a rule than the older varieties. They are specially adapted for sowing on land after roots, for, as their tillering power is limited, they grow more thinly on the ground, and allow more light and space for young grasses and clovers. Moreover, as their straw is generally shorter and stouter they are less liable to lodge and injure the young growing plants.

Failures are, however, liable to occur in wet and cold seasons, which are very prejudicial to these varieties. They may be grown also with equal success on ploughed lea land if it be not too tough, and if precautions have been taken against the attack of grub, to which these varieties succumb much more readily than the varieties of Divisions 2 and 3, because of the smaller number of stems they produce. It is therefore very desirable to protect them by applying artificial manures, which give a very profitable increase of crop, and which these stronger-strawed oats bear better than do the varieties included in the other groups. Their cultivation cannot be recommended on cold wet clays, or on poor exposed soils, or on tough lea land.

Of all the varieties included in this class in the West of Scotland trials, conducted for a number of years on many farms, the most productive in grain have been found to be the Beseler's Prolific, Wide Awake, and the Mounted Police. Following these have been the Thousand Dollar, Siberian, Abundance, Banner, Waverley, and some others. The Banner, which is now widely grown in Britain, is extensively cultivated in Canada and the United States, and has for years held the first position in the comparative trials of a number of the American experiment stations. In extensive trials in Scotland and Ireland it has shown a close equality with the Waverley oat, but has proved itself on the whole to be somewhat more productive. The Thousand Dollar and the Abundance are two of the earliest of the Grain-producing varieties, and are therefore suitable for late districts. The Wide Awake is the latest, and should be grown preferably in the earlier localities. The Mounted Police produces a finer and larger quantity of straw than the others, and also does better on soils of a lower fertility. Somewhat less productive oats of this class, specially valuable for late districts on account of their earliness, are the Tartar King and the Storm King. A still earlier oat grown at the West of Scotland station is the Black Mesdag, a prolific and popular Dutch oat.

The Intermediate Grain and Straw Producers include varieties which fall below the Grain Producers in yield of grain, but excel them in total produce and in yield of straw. This class includes the Potato oat, the Longhoughton, the Berlie, the Early Angus, and other most highly prized Scotch varieties which formerly occupied exclusively the best oat-growing soils of the country. In the West of Scotland experiments it was found that the grain of these varieties constituted about 34 per cent of the total produce, being from 4 to 9 per cent less grain than was found in the Grain Producers. These varieties yield very fine samples of oats of a smaller size of grain than the Grain Producers, but with thin skins and fine quality, and their straw is also more abundant and forms a better fodder. These oats are most suitable for cultivation on fairly good friable soils and well-tilled clays which are not capable of yielding in general more than 60 bus. per acre, and which are not regarded as sufficiently fertile for the growth of the Grain-producing varieties.

This class also includes the Black Winter and Winter Dun Oats, which, introduced first from France, where they were extensively grown, have now been cultivated successfully for a long period in the south of England, and which, on account of the various advantages attendant on winter sowing, still maintain their position there. None, however, of the varieties of this class have attained a popularity equal to that of the Potato Oat, which still remains the first favourite on the good soils of the Lothians and elsewhere. The Longhoughton and the Hamilton resemble it very closely, the former perhaps slightly excelling in yield of grain, and the latter in yield of straw and in hardiness.

The Straw-producing Oats comprise those in which the yield of straw is higher and grain lower than in other divisions. It includes some Continental, with such Scotch varieties as the Sandy, Blainslie, Kildrummy, Barbachlaw, and Tam Finlay. In the West of Scotland experiments these varieties gave a heavier total produce than any others, but the proportion of grain averaged only about 30 per cent, or 10 per cent less than in the varieties classed as Grain Producers. The Straw-producing Oats comprise the hardiest varieties and those best suited for cultivation on cold clays, tough leas, and poor and exposed soils. They possess great tillering power, which makes them better able to resist the attack of grub than other varieties, and they are less liable to be damaged by tulip root or other diseases. Cold seasons and inclement weather have also less effect on them. Their straw is fine and abundant, and makes the best fodder, but on account of the slenderness of the stems it is very apt to lodge before harvest. They are less suitable for growth when grass and clover seeds are to be sown, as the young plants are too much shaded by them, and are apt to be smothered by the lodging of the crop. They are therefore better adapted for growth on ploughed leas, and on land not capable of yielding more than 40 bus. per acre they will probably be found in general more profitable than any of the superior varieties of Divisions 1 and 2.

In the rotation in Scotland, Ireland, and the north of England the oat is grown invariably after lea. No other crop does so well on a grassy turf. Where no other cereal is grown the crop is also taken after roots, beans, or bare fallow, and this is also the position it occupies in the rotations of the south of England. On clay soils in the west of Scotland, unsuitable for green cropping, two oat crops are also commonly grown in succession, grass and clover seeds being sown with the second crop.

The tillage required by the oat crop is of the simplest and cheapest. The only preparation usually given is a single ploughing of the land, on which the seed is afterwards sown and harrowed in. After green crop a shallow ploughing only is necessary. After lea the ploughing should be at least 5 in. deep, and, if the soil admit, a still deeper ploughing is preferable, as the oat roots penetrate well down into the soil. On old turf and on stiff clay it is important to plough not later than December to give time

for the turf to decay, and to allow the surfaces of the stiff furrow slices to be exposed to the disintegrating action of winter frosts. Younger turfs on friable land may be ploughed in January, and land after green crop later in spring up to the time of seed sowing. Clay soils should not be ploughed when wet, for unless they be subsequently acted on by frost they will not harrow down well in spring or afford a good cover for the seed. The use of a skim coulter is advantageous in the ploughing of lea to bury the grass more completely, and to prevent its growing up between the furrow slices. On light soils this is also partially effected by the employment of the drill or furrow presser, which presses the furrow slices more closely together and produces a firmer and more regular seed-bed, in which less seed is liable to be lost by being buried too deeply under the soil. Where the press driller is not used and the ploughing has left the furrow slices not well packed together, one or two turns of the harrows may be advisable before the seed is sown, to fill up the open spaces between the furrow slices, into which seed would otherwise fall and be lost. The seed may be sown broadcast either by hand or machine, or may be drilled in by the corn drill. The latter practice is followed chiefly on rich, friable, and level land free from stones, and after root crop or bare fallow. The former prevails more extensively on poorer, harder, and stonier land, and on sloping land, and on land ploughed out of lea. See arts. SOWING; SEED, SOWING OF; BROADCAST SOWING; DRILL HUSBANDRY.

If the seed is to be sown by drill, the land must first be harrowed down sufficiently to enable the coulters of the drill to pass freely through the surface. When the crop follows roots little harrowing is required for this purpose, but after lea a good deal may be necessary, as otherwise the drill would tear up the furrow slices. When broadcast the seed is sown in the direction of the ploughing, and it falls between the furrow slices in rows which are quite regular if the ploughing has been well done. When drilled in, the seed is sown across the ploughed furrow slices. A single-handed sower with one attendant can sow 15 ac. per day, and with two hands and two attendants can sow 25 ac. Considerable skill is required to make the sowing uniform. The broadcast machine can sow 20 ac. per day, and the drill about 8 to 10 ac. On rich or highly manured land the drill may be set to sow the seed in rows from 8 to 10 in. apart, but on poorer land a width of 6 in. between the rows is preferable. When seeds are sown with the oats, wide drilling is desirable to give light and air to the young grass and clover plants. After the seed has been sown it should be covered to a depth of 1 in. by sufficient harrowing. On lea land there are usually required two harrowings in the line of the ploughing, two harrowings across, and finally two harrowings again in the first direction. The first harrowings must never be across the ploughed ridges, for they are liable to be raised up by the tines, and the seed falling between would be too deeply buried to germinate. On friable land after roots less harrowing is necessary, while on tough old lea twice as much might be required. The harrowing should be continued till the surface of the ground is made smooth. In the autumn sowing of winter oats the land should be left rough on the surface, and the harrowing completed in spring. The land must be dry when seeded, or it cannot be properly harrowed.

The quantity of seed required in Britain varies according to circumstances from 2½ up to as much as 7 or 8 bus. per acre. Under the conditions prevailing in Canada, as little as 1 bus. per acre is found to be sufficient on good soil. The smallest quantity is required with small seed oats sown by the drill on good land, and the largest with large-grained oats sown broadcast on poor land. In the West of Scotland experiments the best quantity in general has been found to be 3,000,000 ordinary commercial seeds per acre, but less suffices on very rich land, and even more might be advantageous on very poor land. The oat plants possess, however, so much power of adaptation, that even a considerable variation in the quantity of seed sown has little effect on the total amount of produce, except perhaps on very poor land. Thin seeding produces taller and stronger plants with thicker stems, which are less easily laid, but make less desirable fodder. Thicker seeding produces shorter, thinner, weaker, and finer stems, which make more palatable fodder, and which also produce a slightly higher yield of grain. The quantity required to be sown in order to supply 3,000,000 seeds varies according to the size and plumpness of the grains, and it may vary from about 5 bus. of small-grained oats like the Sandy and the Potato, to as much as 8 bus. or more of large-grained oats like the Wide Awake, Banner, and Waverley. Before sowing, the germination of the oat seeds should be tested. This is important, as imperfect germination often occurs through the heating of the oats in the stack or from imperfect ripening. Good seed should have a germination of 95 per cent. Thoroughly mature seed should be sown, as it has been found to produce the strongest and most vigorous plants, and this is to be got by sowing only plump, heavy seed corn of a naturally high weight per bushel. Zavitz has reported that at the Ontario Agricultural College the selection of plump, heavy seed oats has given 19 bus. per acre more than light seed in trials continued for eleven years. The seed should also be got from a crop which has grown free from smut, and it should be clean and free from weed seeds.

A change of seed is very advantageous if judiciously made, but otherwise it may be injurious. The change should never be from a poorer or later soil, but from an earlier district, and from a soil on which the oat has been able to attain to its most perfect development. On light and poor soils and in late districts the seed should be changed every two or three years, as the crop steadily deteriorates under these conditions. The Black Tartarian Oat grown on peaty soil must have a change of seed from hard land every two years, or it loses its black colour and becomes brown and thin in the grain. On good soils in early districts a change every five years

or so will be sufficient. New varieties of oats recently produced by crossing are more liable to degenerate, and the seed should be changed more frequently. The best seed is grown on rich clay loams and clays, and favourite districts for seed production are the Carses of Gowrie and Stirling, and the counties of Berwick and East Lothian. Seed grown in Scotland is in great demand both for England and Ireland. Properly effected, a change of seed, which means really a change of environment, of soil, and of climate for the seed and the plant, produces a more vigorous growth, enables the crop to resist more successfully the attacks of insects and of fungoid diseases, and gives an earlier harvest and a larger yield.

The oat is sometimes sown in mixture with other crops. At one time in Scotland it was sown mixed with barley, and it is still cultivated in mixture with vetches for green cutting, or with peas and beans for seeding (see art. BEANS). All these combinations have been found advantageous under suitable conditions. The mixing of different varieties of oats has also been repeatedly tried. The West of Scotland and the North of Scotland experiments have shown that the mixture produces a crop intermediate between what the varieties would give separately, but no evidence has been found that the varieties grown together produced any effect either beneficial or injurious on each other. But mixing may often be advantageous as a means of minimizing risk, of securing a greater uniformity, and of raising the average yield in spite of the variations of seasons. Where it is feared that a Grain-producing oat sown on lea land may be destroyed by grub, or may prove unsuitable for the climate, the danger may be much diminished by sowing it mixed with a Straw-producing oat, while the yield of grain may be much greater than if the latter were sown alone. It is essential in making mixtures that the varieties sown together should ripen about the same time. Such oats as Beseler's Prolific, Mounted Police, and Banner, mix well with the Potato, or Waverley with the Sandy oat, while the Wide Awake suits for mixing with the later varieties of the Straw-producing oats.

The proper time of sowing varies with the district and the variety grown. Winter oats, which are largely grown in the south of England, are sown, like winter wheat, chiefly in September and October, and should not be later than November. Spring oats are sown generally from the beginning of February in the south till the middle of April in the later districts of the north. In most parts of Scotland, however, the sowing is done in the month of March. Earlier sowing than is commonly practised is to be recommended, if the weather and the state of farm labour permit. Early sown oats are much less liable to be damaged by weeds, or by early summer drought, and with the longer time available for growth they yield more abundant grain. On rich soils early sown oats are also less liable to run to straw. Late sown oats may yield well in straw, but are unable to develop the same weight of grain. At the West of Scotland station the best date of sowing has been found to be early in February, though the common practice in the district is to sow late in March. It has been observed there also that the early sown oats are practically free from that very troublesome weed the Runch (*Raphanus Raphanistrum*), which grows most profusely on adjacent plots seeded at the ordinary later period.

In some districts the practice prevails of sowing with lea oats a small quantity of Italian Rye Grass, for the sake of the autumn grazing obtained between the harvesting of the oat crop and the ploughing of the land for the succeeding root crop. In experiments carried out by the writer, at the West of Scotland Experiment Station, it was found that this practice proved exhaustive to the soil and damaging to the succeeding crop. On the other hand, the sowing of Red Clover seeds with the oats at the rate of 4 lb. per acre not only provided some feed for sheep in autumn, but had a most beneficial effect on the succeeding crops. In these experiments, oats of the same variety were sown in adjacent plots with and without Red Clover and Italian Rye Grass and other seeds. The aftermath was ploughed down in autumn, and a barley crop was taken in the succeeding year. These experiments were repeated three times in 1903–4, 1904–5, 1906–7, with the following results:—

	Oats sown without Seeds		Oats sown with Italian Rye Grass.		Oats sown with Red Clover Seeds.	
	Grain, lb. per ac	Straw, cwt. per ac.	Grain, lb per ac.	Straw, cwt. per ac.	Grain, lb. per ac	Straw, cwt. per ac.
Produce Barley—						
Crop, 1904...	2327	26	1975	21¼	2647	33⅜
Crop, 1905...	2790	25¼	2640	25¼	2875	25
Crop, 1907...	2480	27¾	2680	31	3440	39¼
3)	7597	79	7295	77½	8962	97⅝
	2532	26	2431	25½	2987	32½

The sowing of Italian Rye Grass with the oats caused, therefore, a diminution of the yield of the succeeding barley crop, on the average of three years, of ½ cwt. per acre in straw and 101 lb. grain, while on the other hand the growth of Red Clover with the oats caused an average increase in the yield of barley of 455 lb., or more than 8 bus. grain, and 6½ cwt. straw. Similar results have been obtained at the Central Experiment Station, Ottawa, Canada, and the practice of enriching or maintaining the fertility of soils by the growth of Red Clover catch crops is extensively followed throughout the Dominion, and is now also being adopted in Scotland.

The oat, though capable of growing and yielding fair crops on very poor soil, nevertheless responds well to high cultivation and liberal manuring. The oat plants grow somewhat feebly at first, and are much benefited by applications of quickly soluble and immediately available manures supplying nitrogen and phosphoric acid, but nitrogenous manures that act right on to a

late stage in the growth of the crop are also beneficial. The limit of quantity is determined by the liability of the crop to lodge when too luxuriant; but the oat stands much weathering, and is not necessarily or seriously injured by a partial lodging. Some of the shorter- and stiffer-strawed Grain-producing varieties stand liberal applications of manures better than the taller and more slender Straw-producing varieties. The experiments of the West of Scotland Agricultural College, confirmed subsequently by those of the Irish Department of Agriculture, show that the best results are obtained from manures which supply nitrogen, phosphoric acid, and potash. Quantities generally suitable are 2 cwt. superphosphate (30 per cent soluble), 2 cwt. kainit, with ½ cwt. nitrate of soda, and ½ cwt. sulphate of ammonia, per acre. The superphosphate and kainit should be sown either with or some time before the seed, and the sulphate of ammonia also with the seed. The nitrate of soda should be sown immediately after the crop has brairded, or it will cause too much growth of straw and retard ripening. On poor land the above quantities may be increased and even doubled. On light dry soils the kainit may be increased to 4 cwt., and on stiff soils the superphosphate. On very rich soils no manure may be necessary except a dressing of 2 cwt. superphosphate to assist the young plants and to hasten the ripening. In the West of Scotland experiments, on the average of the three years 1896, 1897, 1898, an application of 1 cwt. nitrate, 2 cwt. superphosphate, and 2 cwt. kainit per acre, applied at a cost of 20*s.*, produced an average increase of 12 bus. grain and 6 cwt. straw, of a value at the prices of these years of £1, 17*s.* 6*d.*, being a direct profit of 17*s.* 6*d.* per acre. Besides giving directly profitable returns as shown, the special manuring of the oat assists in choking out weeds, and in enabling it to overcome the attack of the grub (*Tipula oleracea*) which so often completely destroys large areas of the unmanured crop; while other advantages are the better opening up of the land, its enrichment by the residue of the manures and the increased root residue, and the provision of larger quantities of fodder, by which more stock can be kept and more manure produced.

In parts of the country adjacent to large cities, or where there is no green cropping, the crop is sometimes manured with farmyard manure applied at the rate of 15 tons per acre or thereby. This is not a very good practice. The tendency of farmyard manure is to increase straw rather than grain, and the amount of return obtained for the farmyard manure is unremunerative. If applied to the oat crop the smallest possible dressing should be given, and 2 cwts. superphosphate per acre should also be sown with the seed.

After the seed and manures have been sown, and the land harrowed, the crop requires as a rule little further attention till harvest. On some soils on which annual weeds such as groundsel and fumitory are apt to grow profusely, the harrowing is only done to such a degree in the first instance as is necessary to cover the seed, and after the crop has brairded, the harrowing operations are repeated once or twice to destroy the growing weeds. If this can be done in dry weather the weeds can be much reduced in this way, but if the weather be wet the operation is likely to prove ineffective. On drill-sown crops the same effects are produced by horse hoeing between the rows, which may be done after the crop has well started, and this kills the weeds more effectively than harrowing. The final tillage operation is that of rolling. This may be done any time after the seed is sown, but not later than when the oat plants have grown to a height of about 4 in. This operation breaks lumps, consolidates the earth about the seeds and the roots of the young plants, and it leaves the surface smooth for the operations of the reaper in harvest. On many soils, especially on light soils, there occurs a very abundant growth of the mustard weeds Runch and Charlock, which frequently, and especially in dry seasons, grow so luxuriantly as quite to overtop the oat plants and to make whole fields look like masses of yellow flowers. These weeds if left untouched do immense injury to the oats and greatly reduce the yield. They can, however, be completely extirpated by spraying, and their appearance in any quantity on oat fields can now only be regarded as an evidence of ignorant or slovenly farming. (For evidence of damage done to crop, and method of prevention, see art. Mustard Weeds.) Thistles also are apt to grow up in the corn, and if left uncut they will ripen their seeds and pollute the farm, while they also hurt the hands of the labourers in harvest and interfere with the proper handling of the sheaves. The only practicable method of destroying them is to have them pulled out by hand. Workers provided with thick gloves should be sent through the field when the crop is not more than a foot high, and then the thistles will be so strong that they can be easily pulled out of the ground by the roots. No further cultivation is required till the crop is ready for harvesting.

The oats are ready for cutting when the straw begins to change colour under the ear. It is safe to commence when the kernels of the greenest heads can be separated from the chaff by rubbing in the hands. The oat plants ripen unequally, and the grains on each plant do not ripen at the same time. Uniformity of ripeness is only to be got by allowing the crop to stand till it is dead-ripe. But except for seed purposes this is not advisable. When cut dead-ripe much of the grain is liable to be shed in the handling at harvest, from which the oat suffers more than any other cereal, and even before cutting much may be shaken off by storms. The early and the Grain-producing oats are most liable to suffer in this way. Some of the later and the Straw-producing varieties of the type of the Sandy Oat do not readily shed their grain, and hence have an advantage in this respect in a stormy climate. To prevent this loss early cutting of the oats, and especially of the Grain-producing varieties, is advisable. From a week to ten days before dead-ripeness is considered the best time to cut. This does not prevent the filling of the grain, as the process of ripening is continued in the sheaf, but the chaff adheres more firmly to the grain,

which is then much less liable to be shaken out in the subsequent harvesting operations. Early-cut oats must, however, be left longer in the shocks or stooks before they are put into stacks. If the cutting be too early the grains will of course be too thin and the bushel light, but if some loss be incurred in this way it is made up in the superior palatableness and feeding value of the straw. Where there is a large area to be reaped, the cutting should be commenced even earlier in order that no part of the crop except that to be reserved for seed may be dead-ripe before it is harvested. Oats can be safely cut in a moister state than any other cereal crop, and a little dew seldom does any damage, but if cut wet the drying of the sheaves is made more difficult. The fields are first opened by the scythe, and the cutting of the crop is then effected either by means of the reaper or the binder. The latter is the more expeditious and the cheaper method, but on hilly land and with very heavy-lying and twisted crops the reaper is still employed. The oats are bound into sheaves, which should not be too large or the grain will not dry properly. The proper circumference is about 33 inches. For the same reason they should not be tied more tightly than is necessary to permit them to be handled without falling loose. After cutting, the sheaves are at once set up in stooks or shocks containing from six to twelve sheaves each. In wet districts the stooks may be protected by 'hooding', that is, by laying two sheaves along the top of the stooks to run off the rain. (See art. STOOKING.) A still more effective protection, which, however, involves much extra labour, is to put the sheaves into ricks containing about a cartload each. The oats should be ready for stacking in about two weeks after cutting, but the exact time depends on the weather and other conditions. A large crop of strong straw free from grass or clover can be stacked sooner, while a crop of short fine straw containing much grass or clover in the bottom requires a longer time to dry. In the latter case the stooks should be thrown down and the butts exposed to air for some hours before the sheaves are carted off to the stacks. The thorough drying of the oats before they are put into stacks is of much importance, as the oat, on account of its slender and easily compressible straw, is very liable to 'heat' in the stack, and this heating causes loss and damage both to grain and straw in proportion to the degree of the fermentation that takes place. Heated straw becomes musty and unpalatable to stock, and heated grain becomes discoloured, has a lower market value, and is believed to be a common cause of disease in horses. It also forms bad seed corn, and if it germinates at all is apt to produce weak plants. Oats must therefore on no account be stacked when wet with rain. But it is not less important when no rain has fallen, to defer stacking till the natural juices of the plant have become sufficiently dried in the stooks, for oats that have never been wet by rain at all from the time of cutting are even more apt to ferment if they are prematurely stacked. Further protection is afforded by putting the crop in small round stacks of not more than 10 or 12 ft. diameter, and heating may also be prevented by keeping an open air space in the centre of the stacks. This may be done by building the stack round a triangular framework or 'boss'. Stacks of oblong shape or oats stacked in hay or corn sheds are more liable to heat, and the crop requires to be in the best order before being secured in that way.

The stacks should be built on a dry bottom, which may be made of branches of trees, bushes, or loose wood or stones. Special wrought-iron stands for stacks are also made, suitable either for circular or oblong stacks. They not only keep the bottoms of the stacks quite dry and provide for a better circulation of air about the stack, but they also hinder the entrance of rats and mice. (See also art. STACK BUILDING.) The stacks are built with sloping or conical tops to keep out rain, and when not erected in sheds must be protected by thatching as soon as possible after they have been put up. The thatch should preferably be made either of rye or wheat straw, but should these not be available the longest and toughest oat straw should be used. (See art. THATCHING.) The thatch should be firmly fastened with ropes, and the crop can then be regarded as secured for the winter. The stacks should, however, be examined for a week for heating. This can be simply done by thrusting the shaft of a fork or handrake into the heart of the stack in the evening and pulling it out next morning. Should it have become heated in any degree the stack should be at once taken down and rebuilt with the unaffected sheaves, while those fermenting must be set out in stooks again till they have become thoroughly dried. The oats in the stacks are very liable to be damaged by rats and mice, which gather in from the fields after harvest and find in them a safe and comfortable home. They injure the crop not only by the grain they eat and destroy, but also by the unpleasant odour they give both to the grain and the fodder of the whole stack. (For methods of dealing with them see art. RATS, EXTERMINATION OF.) Apart from this damage, the crop can be securely kept in properly thatched stacks till it is required for use.

The average produce of the oat in the United Kingdom in the ten years 1894–1903 was 42 bus., The yield may, however, vary from 20 bus. or less up to 120 bus., which is said to have been got on the fen soils of Cambridge. Yields of over 100 bus. per acre are obtained on some of the rich prairie soils of Canada. In good soils in Britain crops of 60 bus. are considered satisfactory and 80 bus. very good. The weight per bushel may range from 20 lb. with the Shetland oat to 33 lb. with long thin-grained oats and up to 48 lb. for samples of heavy plump grain well winnowed. Standard weights in different parts of the country are 40 to 42 lb. per bus. The number of grains per bus. varies with the shape and size of the grain between 500,000 and 600,000. The yield of straw averages 30 to 35 cwt. per acre, and varies less than that of grain. The relative proportions of straw and grain vary considerably in the different varieties and according to the season, and the grain may constitute from about 25 per cent to more than 50 per cent of the total weight of crop. An

average proportion may be 38 per cent, but the Straw Producers give less and the Grain Producers more.

The oat crop is generally healthy, but suffers seriously sometimes from the diseases of smut and tulip root (see articles on these subjects). The cost of growing the crop, apart from special manuring, on land rented at £1 per acre should not exceed £3, 10*s.* per acre (see art. LABOUR ON THE FARM). The produce usually has a value of from 2*s.* to 2*s.* 6*d.* per bushel for grain suitable for feeding, and from 3*s.* to 4*s.* for seed. The straw may be valued at 30*s.* per ton. [R. P. W.]

Oats.—Parasitic Fungi.—

EAR-SMUT.—The black ears so common in oat-fields consist of remnants of grains and ears destroyed by the smut fungus (*Ustilago avenæ*). The masses of ripe spores form a sooty powder, and are dispersed by wind or animals shaking the corn, or they are mixed with healthy grain during threshing. The smut fungus of oat is quite distinct from that of barley, hence one crop will not infect the other; the details of the life-history are, however, similar (see BARLEY—PARASITIC FUNGI). Like barley, the oat may be infected either in the seedling stage or during flowering. The more common form of oat smut is that which sheds its spores mainly before harvest; there is also a covered smut the spores of which are not liberated till threshing. *Prevention.*—Hot-water treatment, copper-sulphate steeping, and formalin steeping are used as described for barley smut. It appears, however, that the germinating power of oats is injured by steeping more than barley, probably because the loose chaffs do not protect the grain and also retain the steep-fluid till it has time to penetrate to the germ. On this account, copper-sulphate steep used for oats should contain only ½ to ¾ lb. per gallon of copper sulphate, and many authors recommend watering the grain afterwards with lime water made by slaking 1 lb. lime and adding it to 10 gal. water. Formalin solution, 1 oz. to 1 gal. water, checks smut and does not injure the germination of good seed, but if the grain is poorly matured after a wet harvest, it is safer to use 1 oz. to 2 or 3 gal. water; each bushel of seed requires about 1 gal. of solution to moisten it. The hot-water treatment is strongly recommended for oats because it kills the smut and scarcely injures the germination, the water also washes away many smut spores.

LEAF-STRIPE OR YELLOW-LEAF.—This is common and frequently injurious to seedlings. The leaves of young plants droop and show yellow or brownish streaks. The symptoms are thus somewhat similar to attacks by wireworm or to 'segging' (see TYLENCHUS); there are, however, no basal swellings containing eelworms. If the leaves are scraped, the long oval dark spores of *Heterosporium avenæ* will be found. This fungus is closely related to leaf-stripe of barley, and is controlled by similar treatment (see BARLEY—PARASITIC FUNGI). The disease is common on young plants; in one cold unfavourable season we have seen it over a large field accompanying a distinct check in growth. It is not, however, so frequent on older plants as barley leaf-stripe. The promotion of a vigorous early growth is an effective means of checking the disease.

RUST.—This is not often seen on oats. According to Eriksson and others, two rust fungi occur on oat: black rust (*Puccinia graminis* var. *avenæ*) attacks Oats, Oat grass, Foxtail, and Cocksfoot grass, and resembles rust of wheat in that its second host is barberry, but this variety does not infect wheat or barley; crown rust (*Puccinia coronifera* or *P. coronata*) occurs on oats and some grasses, the cluster-cup stage occurs on buckthorn (see WHEAT—PARASITIC FUNGI).

MILDEW (*Erysiphe*) causes white mouldy patches on many grasses and cereals; in the case of oats it may weaken the plant, but rarely does serious damage. [W. G. S.]

Oats, Products of.—The oat plant furnishes in its grain and straw two products of very great economic value. The grain enjoys a unique reputation as food for both man and beast, whilst for feeding purposes on the farm the straw is unsurpassed amongst cereal straws.

OAT GRAIN.—The grain of the oat is characterized by its relatively high proportion of husk, this amounting on the average to about one-quarter of the total weight of the grain. This husk differs greatly in composition from the kernel (caryopsis) of the grain, as is clearly illustrated by the following analyses (Haselhoff and Mach). The sample of oats investigated comprised 71·6 per cent of kernel, 4·8 per cent of inner husk (palea), and 23·6 per cent of outer husk (flowering glume).

	Whole Grain.	Kernel.	Inner Husk.	Outer Husk.
	per cent.	per cent.	per cent.	per cent.
Moisture	12·27	11·53	9·43	9·71
Albuminoids	8·45	10·94	2·77	1·75
Oil	4·95	6·63	0·46	0·38
Crude fibre	9·45	2·10	29·85	31·33
Ash	2·41	1·97	6·48	4·34
Soluble carbohydrates, &c. (by difference)	62·47	66·83	51·01	52·49
	100·00	100·00	100·00	100·00

It will be noted that the albuminoids and oil are contained almost entirely in the kernel, whilst the husk contains the bulk of the crude fibre, and differs indeed but little in composition from cereal straw. The proportion of husk to kernel in a sample of oats must therefore be a factor of great importance in determining its value for feeding purposes (as well as for the

production of oatmeal), and must be given due weight in comparing the merits of different samples. The differences in this respect between varieties of oats are well illustrated by the following averages given by Hendrick and Greig with oats grown in the north and west of Scotland in the four years 1901–4:—

Variety.	Number of Analyses.	Average Percentage of Husk in Air-dried Grain.
		per cent.
Sandy	11	22·5
Goldfinder	13	23·1
Scots Birlie	7	23·5
Newmarket	14	23·9
Potato	14	24·1
Hamilton	7	24·2
Waverley	10	24·2
Banner	14	24·8
Wide Awake	10	25·6
Tartar King	6	28·2
Storm King	9	29·2

It may be noted that whereas the varieties Sandy, Potato, Scots Birlie, Hamilton, are all characterized by relatively low proportions of husk (*i.e.* are thin-husked), there is much more variation amongst the more recently introduced varieties, some being very thin in the husk, whilst others are decidedly thick-husked. More detailed information on this subject may be obtained from the bulletins of the West of Scotland Agricultural College.

The composition of the oat is subject to greater fluctuations than that of any other common cereal grain. The range of variation and mean composition found by Dietrich and König in 625 samples of oats are given as follows:—

	Range of Variation.	Mean.
	per cent.	per cent.
Moisture	6·2 to 20·8	12·1
Albuminoids	6·0 „ 18·8	10·7
Oil	2·1 „ 10·6	5·0
Crude Fibre	4·5 „ 20·1	10·6
Ash	1·3 „ 8·6(?)	3·3
Soluble carbohydrates, &c. (by difference)	48·7 „ 64·6	58·3

The 'mean' composition given is probably slightly below the average of British-grown oats in albuminoids and oil, these being commonly found present to the extent of about 12 per cent and 6 per cent respectively. There is also some reason to believe that the general quality of the grain is rather higher in the northern than in the southern half of the country.

Information of great interest and value as to the differences in composition, more particularly with regard to albuminoids and oil, between different varieties of oats has been obtained by Hendrick and Greig in connection with the four years' experiments previously mentioned. His results are summarized in the following table, in which the percentages of albuminoids and oil in the dry kernels are given, the influence of the varying proportion of husk being thereby eliminated.

Variety.	Number of Analyses.	Oil. Variation.	Oil. Average.	Albuminoids. Variation.	Albuminoids. Average.
		per cent.	per cent.	per cent.	per cent.
Old Varieties—					
Potato	14	7·50 to 10·22	9·22	12·31 to 16·31	15·16
Sandy	11	8·23 „ 10·78	8·99	14·59 „ 20·38	16·33
Hamilton	7	7·58 „ 9·63	8·81	12·82 „ 15·84	14·30
Scots Birlie	7	7·21 „ 9·59	8·45	12·21 „ 17·31	15·12
Average of four old varieties ...	...	...	8·87	...	15·23
New Varieties—					
Wide Awake	10	6·19 „ 9·66	7·43	12·09 „ 15·97	13·47
Banner	14	5·13 „ 8·44	6·99	12·90 „ 16·72	14·22
Waverley	10	6·28 „ 7·81	6·98	12·61 „ 16·31	14·77
Thousand Dollar	7	6·22 „ 7·29	6·84	12·28 „ 15·65	13·95
Siberian	10	6·25 „ 7·77	6·83	11·81 „ 15·40	13·85
Goldfinder	13	5·79 „ 8·23	6·68	13·28 „ 18·22	15·04
Newmarket	14	4·60 „ 7·95	6·60	12·28 „ 15·81	14·33
Tartar King	6	5·52 „ 6·92	6·27	13·62 „ 15·98	14·80
Storm King	8	5·01 „ 7·62	5·98	15·43 „ 17·50	16·49
Average of nine new varieties ...	...	...	6·73	...	14·55

It will be noted that the old varieties, especially the Potato and the Sandy, contained a decidedly higher percentage of oil than any of the newer varieties, whilst the Tartar King and Storm King were very poor in this valuable ingredient.

The older varieties were also in the main richer in albuminoids than the newer varieties, and it may be, as Hendrick and Greig suggest, that the high reputation of Scotch oatmeal is partly due to their special richness in oil and albuminoids.

The composition of the oat is probably affected further by the character of the season. Hendrick found that the percentage of oil was higher and of albuminoids lower in the dull cool seasons than in the fine dry seasons.

The oat is apparently about equally digestible for cattle, sheep, and horses, and, apart from the somewhat low proportion of the total organic matter that is digested owing to the abundance of husk, it compares favourably in digestibility with other grains. Gay (1896) found that in the case of cattle and sheep the digestibility of the grain was in no way affected by crushing or grinding, but that in the case of

horses it was appreciably increased, especially by grinding. The conclusion cannot, however, be drawn from these observations that it will be advantageous to feed oats to horses in the crushed or ground condition rather than whole, since digestibility is but one of several factors that need to be taken into consideration.

Apart from the relatively high proportion of crude fibre, the outstanding feature in the composition of oat grain is its richness in highly digestible oil as compared with wheat, barley, and rye, and to this is partly due its special suitability for animals on whose energies large demands are made, such as the working horse or racehorse.

The albuminoids and carbohydrates of oats appear to be, in the main, identical with those of wheat and barley, the most abundant albuminoid being glutenin, whilst starch forms the bulk of the carbohydrate matter.

The oat grain is the most highly valued of all cereal grains for all feeding purposes on the farm. This is due not only to its easy digestibility, high oil content, and agreeable taste, but also to the specific beneficial effects which oats apparently produce over and above their mere nutritive value, upon the progress and general wellbeing of the animals. What these specific effects may be due to, can as yet only be surmised. A view widely held ascribes the specific action of the oat, partly to the presence of an alkaloid-like substance (avenin) which, according to its discoverer (Sanson, 1883), exercises a stimulating effect upon the nervous system associated with the digestive organs. This view still rests solely upon the authority of Sanson, no other investigator having succeeded as yet in confirming the presence of avenin in the oat. The grain certainly does contain (Fournet) small quantities of a glucoside (coniferin) which during digestion gives rise to a vanilla-like substance (vanillin), whilst (Schulze) the alkaloid (trigonellin) to which the stimulating properties of fenugreek are largely due is also present in minute amount. These two substances probably exercise a beneficial 'spicing' influence upon the utilization of the grain by the animal. Probably of far greater influence is the mechanical stimulation of the walls of the alimentary canal by the husks, whereby an abundant flow of the digestive juices is ensured. Moreover, with its higher content of crude fibre the oat approximates in character to the natural food of herbivorous animals more nearly than do the other cereal grains.

As grain food for *horses* the oat is unsurpassed; indeed where heavy demands are made upon the animals it can hardly be dispensed with. Horses utilize oats equally well at all ages and all kinds of work. In feeding oats, care should be taken to ensure thorough mastication either by crushing the grain or by suitable admixture of chaff or other coarse fodder. The most general practice in horse-feeding is to mix the oats with hay, straw chop, and chaff, the mixture being moistened with water to facilitate its consumption and prevent the chop or chaff being blown away or pushed aside. Thorough mastication and insalivation of the food are thereby secured. There should be no necessity to crush the grain before feeding, except in the case of horses incapable of perfect mastication owing to deficiency or defects of teeth. There is indeed a widespread belief that the spirit and endurance of the horse are less easily maintained and the heating effects are greater when the grain is supplied in the crushed form than when fed whole. It is also a common belief that crushed oats deteriorate rapidly during storage.

Newly harvested oats must be fed with caution, especially if somewhat damp, since digestive troubles have often been found to arise therefrom. The trouble is probably largely attributable to the activity of fermentative organisms on the surface of the fresh grain, and may be guarded against to some extent by mixing a small proportion of salt with the grain and allowing to stand for a few days. To be perfectly safe, however, the oats before being fed should be stored under good conditions for two or three months.

Mouldy and musty-smelling oats are much more dangerous to use, and if badly affected can only be rendered safe by steaming or boiling with water. If only slightly musty they can be improved by storing in dry well-ventilated rooms and turning over frequently. Oats that have heated in storage may be safely used, provided that they are not in other ways objectionable.

The high value of oats for horse-feeding and for milling purposes greatly restricts their use for other classes of stock, although they usually give excellent results when available. Crushed or ground oats are specially favoured for the feeding of calves and other growing animals, and are also highly esteemed for fattening and milk production. When fed to fattening animals they are said to conduce to excellent 'grain' and flavour in the meat. For milch cows the oat is not surpassed by any other grain in its influence upon the quantity and quality of milk secreted, and on the general wellbeing of the cows. It has indeed been claimed (Hagemann) that the inclusion of oats in the ration of the milch cow leads to better utilization of the remaining ingredients. If given too freely, however, the butter fat acquires an undesirably soft character, and for this reason it is advisable, where the milk is to be used for butter, that along with the oats some food with a hardening tendency upon the fat (*e.g.* cotton-seed, peas, roots, potatoes) should be fed. Oats, in the form of meals, are excellent food for pigs, being little inferior to barley. They are also favoured by many as grain food for poultry.

The proportions of fertilizing ingredients in the oat grain are much the same as in other cereals, amounting on the average to about 1·7 per cent of nitrogen, 0·7 per cent of phosphoric acid, 0·5 per cent of potash, and 0·1 per cent of lime. Using the methods and unit values suggested by Hall and Voelcker for calculating compensation allowances for the manurial value of foods consumed, these amounts correspond to a manurial value of about 14*s.* for each ton of oats consumed during the last year of a tenancy.

Oat Milling Offals.—In addition to the

large quantities of oat grain that are fed directly to stock, a very considerable amount is subjected to milling processes for the manufacture of the various oat foods (groats, oatmeal, oat flour, Quaker oats, &c.) that are so widely and largely used as human food, notably in North Britain.

The milling process is, in the main, similar to that employed for wheat (see FLOUR), except that there must be a preliminary treatment of the cleaned and dried grain to remove the closely adherent husk. After removal of the husks (oat shudes) the kernels are gradually milled down to the required degree of fineness, a certain amount of 'offal' (oat dust, sids) being obtained from the sieves and purifiers at each stage. These offals should consist mainly of the outer seedcoat of the oat kernels and the layers immediately below it, mixed with a certain amount of meal particles of various grades. Such offals are rightly described as 'oat bran' and 'oat feeding meal', and should be practically free from husk. The only too prevalent practice of grinding up the husks and mixing them into the bran cannot be too strongly deprecated, since not only is the nutritive value of the oat bran thereby seriously lowered, but the presence of husk may be an actual source of danger, especially in meals that are fed to pigs. Other adulteration of oat offals is also occasionally met with, such materials as ground straw, coffee-bean husks, sawdust, and gypsum having been identified in recent years in meals offered as oat products. For these reasons there is great uncertainty as to the real value of any particular 'oat feeding meal' unless its composition and character have been determined. The proportion of 'offal' obtained varies greatly with the character of the oats milled, but, as a rule, oats grown in the north of Scotland yield about 60 to 65 per cent of oatmeal and 20 to 25 per cent of 'offals', the husks forming roughly three-quarters of the latter. These figures indicate a loss of weight (moisture) of about 15 per cent in the drying of the grain. The following data are given by Kellner for the composition of various oat products met with on the German market:—

	TOTAL.						DIGESTIBLE.					
	Moisture.	Crude Protein (Albuminoids).	Oil.	Soluble Carbohydrates, &c.	Crude Fibre.	Ash.	Crude Protein	Pure Protein.	Oil.	Soluble Carbohydrates, &c.	Crude Fibre.	'Starch Value' per 100 lb.
	p cent.	p. cent.	p cent.	p. cent.	p. cent	p. cent	p. cent.	p. cent.	p. cent.	p. cent.	p. cent	lb.
Oat husks ...	14·0	1·9	0·5	45·8	32·4	5·5	—	—	0·2	16·5	10·7	18·3
Oat bran	9·6	7·6	2·7	53·8	21·6	5·7	3·8	3·4	1·5	37·5	8·0	45·3
Oat feeding meal (coarse)	10·0	11·7	4·7	52·4	15·0	6·2	8·8	7·6	3·8	38·3	7·5	55·9
Oat feeding meal (fine) ...	10·0	16·2	6·6	54·5	7·5	5·2	12·6	11·0	5·4	42·0	3·7	64·2

OAT HUSKS in themselves have little feeding value. They can best be used as a partial substitute for coarse fodder in feeding horses and cattle. At present they are chiefly ground to meal (oat-husk meal) and exported.

The other offals are excellent foods for horses, cattle, and, if free from husk, for pigs. Oat dust (or oat bran) is specially valued for poultry and pigs.

OATMEAL, owing to its relatively high cost, is not much used for stock except in special cases such as the rearing of calves, where it has been used with considerable success as a supplement to separated milk. It is more widely used for human consumption in Scotland than in England, being apparently better suited for the colder northern climate. In warm climates it appears to have a heating tendency on the blood, giving rise to eruptions on the skin. Perhaps for this reason also it is better suited for outdoor workers than for those engaged in sedentary occupations. The composition of Scotch oatmeal is somewhat as follows:—

	per cent.
Moisture	10
Oil	8
Albuminoids	15
Crude fibre	3
Ash	4
Soluble carbohydrates, &c. (by difference)	60

It is thus notably rich in albuminoids and oil.

OAT STRAW is commonly regarded as the most valuable of cereal straws for feeding purposes. This is partly due to its relatively soft character, the labour necessary for mastication being thereby reduced, and also partly to the fact that the oat crop is commonly cut before it has reached the stage of maturity at which the other cereal crops are harvested, so that the removal of easily digestible nutrients from the stems into the grain will be less complete. Moreover, when harvested in good condition, it is better relished by stock than either wheat or barley straw. It is indeed only as litter that it is in any sense inferior to the other straws. Like all other fodders its composition and digestibility are subject to great variation, but in general are much as follows:—

	Composition.	Digestibility (Ruminants).
	per cent.	per cent.
Moisture	14	—
Albuminoids	4	33
Oil (ether extract)	2	36
Crude fibre	37	54
Ash	6	—
Soluble carbohydrates, &c. (by difference) ...	37	46
	100	

Hendrick found but little difference in composi-

tion between the straws of different varieties. If, as many practical men maintain, the straw of the newer varieties is inferior in feeding value to that of the well-known old varieties, this arises probably less from differences in chemical composition than from differences in the mechanical character of the straw.

The *ash*, as in the case of other cereal straws, is rich in silica and potash, the latter commonly amounting to 1½ per cent of the whole straw, whilst the proportions of phosphoric acid and lime are usually about 0·2 per cent and 0·4 per cent respectively. These proportions along with the 0·6 per cent of nitrogen lead to a compensation value for manurial residues from the consumption of 1 ton of such straw during the closing year of tenancy, amounting to about 10*s*.

Oat straw is an excellent fodder for cattle and sheep, and, when not too soft, for horses. It is commonly regarded as superior to wheat and barley straws, and quite equal to poor hay. When fed to milch cattle it has been said in some cases to have imparted a bitter taste to the milk; but this has probably been due to some contamination or defect in the condition of the straw used. It is also said to impart a tallow-like character to the butter fat—an effect, however, which is common to all kinds of straw when fed too liberally. The value of the straw depends largely upon its condition. If mouldy or badly infected with fungoid disease it must be chaffed and steamed before it can be fed with safety.

Oat Chaff is the most nutritious of cereal chaffs, being fully equal to good oat straw. Like all cereal chaffs it is rich in crude fibre (25 to 30 per cent) and ash (9 to 11 per cent). The latter is composed almost entirely of silica.

Oat Hay is the product obtained by cutting the oat crop before the grain commences to ripen, and curing by exposure to the sun as in ordinary haymaking. This practice is largely followed in America and in South Africa, where the oat is largely grown as forage, partly to be eaten green, but mainly to be made into oat hay. The composition of South African oat hay is given by Ingle as follows:—

	per cent.
Moisture	8·1
Albuminoids (crude protein)	4·9
Oil (ether extract)	3·9
Crude fibre	31·6
Ash	4·3
Soluble Carbohydrates, &c.	47·2
	100·0

It is an excellent fodder, and in some parts of South Africa is the staple food of horses, mules, &c. Animals fed exclusively on oat hay are, however, often found to suffer from bone trouble (osteoporosis), this being due, according to Ingle, to the excessive amount of phosphoric acid relatively to the lime present in the oat hay.

[C. C.]

Oats, Statistics of.—The oat crop occupies a position of growing importance among the cultivated cereals of the world,—an area of 123,000,000 ac., with a growth of wellnigh 400,000,000 qr., has been assigned to this grain alone. Russia in her European and Asiatic provinces accounts for 44,000,000 ac.—more than a third part—of this surface, and for an average production of something like 92,000,000 qr., whereof less than a tenth seems to enter the export trade. Second in area come the United States, where a production, even in a year of poor yield equalling the Russian total, is obtained from 32,000,000 ac. under oats. In the past twenty years the States have added 36 per cent to their oat fields—a notable substitution of oat crops for a place in rotation farming, which is taking the place of continuous wheat growing, being one of the features of the time. Probably the German oat crop, with a record yield of 65,000,000 qr. in 1907, takes the next highest place; France follows with an average outturn of 33,000,000 qr., and Canada already contributes 31,000,000, with still larger future prospects.

The British crop of 22,000,000 qr. in average years comes considerably short of these totals; its local importance is recognized when the excess of this total over that of all other cereals is observed. Grown on an area of only 4,169,000 ac., the suitability of this cereal to our agricultural conditions here is displayed by its high yield of more than 42 bus. per acre harvested. Even more than this has been grown on occasion. The maximum yield of the past sixteen years reached 44·5 in 1902, while the minimum yield was that of 1896 with 38 bus. Wide, however, is the range of area and of yield between the different sections of our country, as the following table of the crop in 1908 clearly indicates:—

Division.	Acreage.	Produce.	Yield per Acre.
	acres.	quarters.	bushels.
England ...	1,959,000	9,994,000	40·8
Wales	202,000	864,000	34·3
Scotland ...	948,000	4,595,000	38·8
Great Britain ...	3,109,000	15,453,000	39·8
Ireland	1,060,000	6,548,000	49·4
United Kingdom	4,169,000	22,001,000	42·2

The relatively larger yield credited to the Irish oat crops is strikingly apparent, assuming that the official conversion of the weight into measure is correct. Although the excess has not usually been so prominent as in the year just quoted, the feature indeed is noted annually in these returns, and a ten-year average gives the Irish yield of oats as 46¼ bus. as compared with the British figure of 39¾ bus. Any examination of the yield of particular districts in Great Britain shows, however, even wider differences. The oat crop of the county of Cambridge—51 bus. per ac. on a decennial average—exceeds even the Irish figure, and that of the Eastern Division of England is identical with it, while the lowest county averages are found in the Welsh counties of Brecon and Carmarthen, where less than 28 bus. is recorded. Except in the Shetland Islands no Scottish county falls to this level, while decennial means of 46, 45, and 44 bus. per acre are reached in Ayrshire, Forfar, and East Lothian.

Taking the United Kingdom as a whole, the

area under oats has exhibited no such decline as is observed in either wheat or barley. The total surface thus occupied for 1908 is within a trifle the same as that for 1880, and if in the interval a total of over 4,500,000 was reached in 1894–5, the average level has been maintained round the figure of 4,200,000 ac. In England, taken separately, the crop has indeed been somewhat extended, while the Irish oat area has diminished.

The average price of oats, according to the English official values, has not shrunk during the past decade, although since 1891 an annual price of 20*s*. per quarter has only once been recorded. The remarkably low values of 14*s*. 6*d*. and 14*s*. 9*d*. per quarter which were returned in 1895–6 have never again been repeated, and the 17*s*. 10*d*. of the English average for 1908 is just over the mean of the last five years. A very large proportion of the oat crop never enters the market, and the local range of price for that sold varies widely. It may be noted the separate returns for the corn market of Edinburgh have never shown less than 20*s*. per quarter during this century and averaged 21*s*. in 1908. [P. G. C.]

Oat Wainscot Moth, a moth commonly occurring in fenny districts, whose larvæ feed on the leaves of oats and reeds. See HELIOTHIS OBSOLETA.

October, Calendar of Farm Operations for.—

1. SOUTHERN BRITAIN

ARABLE FARM.—This month is one of the busiest seasons of the year. Clover and bean stubbles that have been ploughed up last month are now ready for wheat sowing. Autumn cultivations are pushed forward and completed. Stubble ploughing for winter beans, oats, and barley proceeds, and the land, if clean enough, can have the farmyard manure applied to it directly without previous autumn cultivations. The next break of winter tares in succession is sown. Late potatoes are lifted and pitted; the lifting of roots can be started at the end of the month. The cabbages on the seedbeds sown in August are now ready for transplanting. Hop-picking is generally all finished early in October. Manures can be applied to grasslands. Roads and ditches should be attended to.

STOCK.—It is dangerous to feed new chaff, oat straw, and oats in quantity to horses till they have become mellowed a little. Many young horses are first broken in at this season, and then allowed to run at grass in the winter. These should not be pampered up in warm stables when they are shortly to be turned out. Young store cattle should be brought in to more sheltered fields or to yards at night at the end of this month. Yearlings however may be left out a little longer. Fattening cattle are stall-fed, and there may still be some cabbages and kohl-rabi available for them and also for the dairy cows. Turnips sown in May may also be fed. Dairy cows are kept in the house at nights, but still get out to the pastures through the day. Cheesemaking is practically finished for the year, and the winter price for whole milk starts from Michaelmas Day. Dry cows can still be left out in the pastures, but are better to be brought in when near calving.

Dorset ewes now commence lambing, and these lambs are to be fattened for the Christmas markets. Cross- and half-bred sheep are now put to the ram.

On many farms the sheep are taken off the stubbles and folded on to roots, or put on the meadows. Those set aside for fattening get an allowance of hay, roots, and cake. Dipping can be done in the early part of the month.

Fattening pigs can get the small potatoes from the fields along with their other food. Sows should be timed not to have litters later than the beginning of this month.

In the poultry yard, eggs are scarce now, and pullets are the most reliable layers, as older birds have not yet got over their moulting. It is important to clear off all surplus stock now. In hunting districts one should see that all are housed at night, on account of the foxes, which are especially bad at the commencement of the hunting season. [P. M'C.]

2. NORTHERN BRITAIN

The most pressing work of the month is the finishing of any remaining harvest. No opportunity should be lost to bring it to an end, as owing to the advance of the season the days quickly become shorter, and the periods of sunshine so brief that drying becomes daily more difficult. In weather unsuitable for stacking, thatching should be kept well forward, so as to effectually protect what has already been secured.

Where potatoes are grown, the main work of the month will be the raising and storing of this crop. With the second early varieties this work may begin any time after the beginning of the month, and the main crop varieties a little later on. Before the work begins, it should be seen that a full supply of baskets is provided, that drills are dug at suitable intervals where it is desired a beginning should be made, and that sufficient is dug off the ends of the drills to allow the horses to get out and turn with convenience.

Potatoes, after being dug, should not be allowed to get rain. If rain comes on, digging should at once stop, and if the potatoes should be caught in a shower, on no account should they be taken direct to the pit. All carts with wet potatoes should be set aside in a shed and allowed to stand there till thoroughly dry. Make the pits narrow. In dry districts they can be made of greater capacity than in those of greater rainfall, but it is always good policy to make them small for the district, as the extra cost expended in covering will be far more than saved in dressing.

This is one of the best seasons for applying dung to grassland or to land from which a hay crop has been taken. If wheat is sown it should be in readiness, and be got in whenever opportunity occurs. Stubble ploughing may now be attended to. Cows in milk will now require extra feeding, and for this season cabbages are one of the best foods available. Bullocks seldom

do any good on the pasture after this, and should be housed and put on winter fare. Sheep and lambs usually have plenty of food, but if it is desired to hurry them on, they should be liberally supplied with cake. Where not already done, dipping should be attended to during dry weather. [J. S.]

October, Calendar of Garden Operations for.—

1. Southern Britain

The harvesting of fruit, the transplanting of trees and shrubs of all kinds, the making of strawberry and raspberry beds, and the lifting and housing of tender plants for the winter all require to be done this month. Dahlias, cannas, fuchsias, pelargoniums, bouvardias, solanums, and salvias should be taken up before the end of the month, and placed out of the reach of frost. Roses and other shrubs to be used for forcing should be lifted and planted in pots or tubs for convenience, and fruit trees against walls will require to be overhauled for nailing. As fruit is gathered and placed in the fruit-room it should be kept dry and well ventilated, and care should be taken not to bruise it, or handle it more than is necessary. Cuttings of gooseberries and currants should be set in the open border. Vineries in which grapes still hang require to be kept as cool as possible, admitting an abundance of air on all dry days. Where the fruit has been gathered the house should be thrown wide open, and as soon as the leaves have fallen the canes should be washed with a solution of soft soap and paraffin, the walls whitened, and the glass cleaned. Similar treatment should be given to peaches grown under glass. Where frames or handlights are available they should be used for the production of vegetables in winter and spring, and during this month sowings should be made of lettuces, cabbages, endives, and radishes.

In the kitchen garden beet, carrots, and potatoes should be taken up and stored; cabbage for spring should be transplanted; tomatoes should be gathered and hung in a warm place to ripen; the final earthing-up of celery should be seen to; and cauliflowers that will require protection may be pricked out in positions where they can be covered with frames or handlights. All fallen leaves, potato haulms, &c., should be collected and burnt.

Borders containing shrubs require to be overhauled and put in trim for the winter, preferably after the leaves have fallen. All vacant land should be dug and left rough for the winter, adding manure when the crops are put in. Where spring bedding is done with such plants as wallflowers, polyanthuses, violas, doronicums, sweet williams, pyrethrums, and anemones, the beds should be prepared and filled before the end of the month, so that the plants may become established in the soil before winter sets in. Lawns may now be overhauled, and either patched or relaid with fresh turf. Go over the garden early this month and decide what changes in the way of transplanting and of bedding are required, so that the work may be done during the winter. [W. W.]

2. Northern Britain

Sharp autumn frosts, which are not infrequently followed by heavy rains, may now be expected. Lift and store the various root crops as circumstances warrant. Perhaps the most tender of all the root crops is beetroot, which should be lifted before it is affected by hard frost. In lifting the roots exercise great care to prevent injury by breaking or bruising, and do not dress off the leaves in the same way as is done with carrots or turnips, but leave about 2 in. of the leaf-stalk on, remembering that if the roots are 'bled' they are, when cooked, pale-coloured and harsh to taste. All carrots, excepting the very latest, should also be lifted and stored in pits, or in sand, in a cool house for convenience. Parsnips should be left out as long as practicable, as they more readily depreciate in quality when lifted and stored in the orthodox way than any of the others. Late potatoes must also be lifted when weather conditions are favourable.

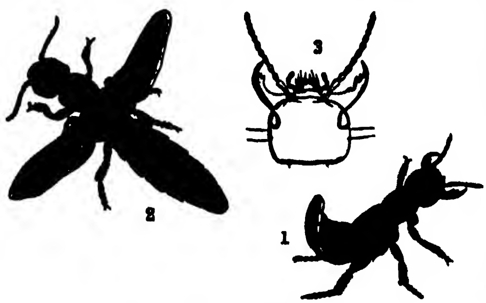
Examine all the breaks of winter crops and remove decaying leaves. If the crop of late cauliflowers are 'heading' more quickly than they can be used, pull up the plants as the heads open out and become exposed, and plant them in a bed of damp sand or soil under cover of a cold frame or shed. They will keep in good condition for several weeks at this season if carefully handled.

Where difficulty is experienced in keeping parsley over the winter in the open ground, provision should be made to maintain a supply of this almost indispensable article by preparing a suitable frame and planting therein such quantity as may be considered necessary. Select and carefully lift good strong plants and do not overcrowd them, making the soil as firm as possible when planting. Give air as freely as weather conditions warrant. If a frame is not available, plant at the foot of a wall or where some protection can be given.

If not done at the end of last month, the propagation of calceolarias, pentstemons, antirrhinums, violas, and such plants which can be wintered in cold frames, ought to be done as early as possible. Some discrimination is necessary in very moist districts in the treatment of cuttings inserted late in the season. Should the soil be in a proper condition as to moisture, and the cuttings not permitted to flag before planting, the cuttings will root quicker and keep better over the winter if they do *not* receive the orthodox watering-in; a slight dewing overhead will suffice. Keep the frames closed for ten or twelve days, after which admit air carefully and gradually; and should the weather keep mild and open, the sashes should be kept off entirely *at night*. This practice must be modified to suit the various situations, and is not applicable to dry or windy places, where the frames must be kept closer night and day to preserve the proper degree of moisture in the atmosphere and soil, without which the cuttings would not strike root. Seedlings of hardy plants not sufficiently strong to withstand the rigours of winter in our changeable climate

ought to be pricked out in frames. Use fresh soil mixed with leaf mould and sand, without any manure, and made moderately firm. Treated similar to cuttings, good plants will be produced for spring planting. [J. WH.]

Ocypus, a genus of beetles belonging to the family Staphylinidæ. There are ten British species, which are found under stones, clods of earth, at roots of trees, in vegetable refuse, and in dry dung. They have very short wing cases, but ample wings, and the long body is capable of movement upwards over the back. They are mostly nocturnal and carnivorous in their larval and adult stages. To some extent they are beneficial, but they often attack and devour earthworms. One of the best known is the Cocktail or Devil's Coach Horse (*Ocypus olens*), a black species about 1 in. in length. This ferocious-looking beetle, when disturbed in day-time, opens wide its jaws, which are large, and turns its tail up over its back in a menacing attitude, and at the same time it extrudes from



Devil's Coach Horse (*Ocypus olens*)

1, Standing; 2, with wings spread; 3, the head magnified, showing the formidable jaws open.

the end of its tail two white vesicles, which appear to be connected with some fluid of a disagreeable odour.

The larva of this beetle is typical of the others; it is very rapacious, with head broader than the thorax, with large and powerful jaws, the abdomen long and narrowing to the apex, which is furnished with an anal appendage about twice as long as the last segment, and two spine-like bodies (cerci); this larva is pale-yellowish, with blackish head and dark areas over the body. The larvæ hibernate, and in spring they make a cell in the soil, in which they become pupæ.

The pupa is shiny-yellow, and has a crown of hairs on the front of the thorax. [F. V. T.]

Œnanthe (Water Dropwort, nat. ord. Umbelliferæ).—This genus contains about twenty species, seven of which are natives of Britain.

Œ. crocata, or Hemlock Water Dropwort, is found in ditches and marshes. It has thick fleshy roots which are very poisonous both to human beings and cattle.

Œnanthe fistulosa (common Water Dropwort), a pretty plant, with hollow stems and leaf-stalks, found in marshes and bogs.

Œ. pimpinelloides (Callus-fruited Water Dropwort or Meadow Parsley) is found in meadows, banks, and waste places. *O. peucedanifolia* (*Œ. silaifolia*), Sulphur-wort, is found in ditches and moist places. *Œ. Lachenalii* (Parsley Water Dropwort) occurs in fresh and saltwater marshes. *Œ. Phellandrium* (the Horsebane) has the lower or submerged leaves finely divided, and is found in ditches and ponds. *Œ. fluviatilis* is the River Dropwort; has floating stems and finely divided leaves. [A. E.]

Œnothera, a large genus of plants of the nat. ord. Onagraceæ, widely distributed in North and South America, a few of which have become naturalized in this country. Many of them have large showy flowers, which usually open in the evening, whence the popular name of Evening Primrose by which the garden sorts are known. Some are perennials and some are annuals, and all appear to be easily cultivated. The best of these grown in gardens have been introduced from the United States, such as *Œ. Lamarckiana*, a form of *Œ. biennis*, which grows 6 ft. high and is particularly beautiful in gardens by the sea, its flowers being from 4 in. to 6 in. across, primrose-yellow, and very fragrant. Once established in a garden it seeds and comes up freely. *Œ. fruticosa* is a perennial of shrubby habit about 3 ft. high, with large yellow flowers. *Œ. glauca* and its variety *Fraseri* are excellent for the rock garden. Other good sorts are the following: Annuals—*acaulis*, *bistorta*, *Drummondi*, and *triloba*; perennials—*macrocarpa*, *marginata* (flowers white), *speciosa*, and *Youngei*. They are all easily propagated by seeds or division. *Œ. biennis*, known as the Tree Primrose in Virginia, is cultivated in Germany for its long fusiform roots, which are eaten as a vegetable. The seeds being sown broadcast in April on well-dug ground, and either thinned or transplanted to 1 ft. apart. In the autumn they are dug up, the leaves trimmed off, and the roots stored in a cellar. They are eaten boiled, and served up with white sauce as for salsify. They are also used for flavouring soups, are easy of digestion, and said to be very nourishing. [W. W.]

Œstrus, or **Œstrum,** is the period at which the female animal receives the male. With some species it occurs only once in a single sexual or breeding season (*e.g.* the bitch); with others it may recur at relatively short intervals in one season, but any œstrus may be succeeded by pregnancy if coition, followed by conception, took place, in which case œstrus cannot usually occur again until the next breeding season (*e.g.* the mare, cow, and sheep). The former class of animals are described by Heape as monœstrous, the latter are called polyœstrous, and the entire cycle of changes in each case is known as the œstrous cycle. In a typical monœstrous animal such as the bitch, the entire œstrous cycle is divided into four periods as follows:—

1. *Anœstrum*, when the generative organs are in a state of rest, the uterus or womb being relatively thin-walled and anæmic, and the ovaries or essential female organs in a condition of comparative inactivity, since they contain no ripe ova or eggs, and show no signs of ova having been recently discharged. In the case of the bitch the ancœstrum (in the absence of pregnancy) usually lasts for about five months.

2. *Procœstrum*, or period when the animal is 'coming on heat'. At this time the uterine wall undergoes a process of growth, becoming slightly increased in thickness and congested with blood. This process is followed by a breaking down of some of the bloodvessels. The blood passes out into the vagina and so to the exterior, where bleeding may be observed at the generative opening. Thus the procœstrum is divisible into two stages, the first being characterized by uterine growth and congestion, and the second by destruction and bleeding. Meanwhile the ova are ripening, the Graafian follicles or vesicles which contain them beginning to protrude appreciably from the surface of the ovaries. The entire procœstrum in the bitch lasts about ten or twelve days.

3. *Œstrus*, or the period of sexual desire. To this period coition is usually restricted. With its commencement external bleeding from the vagina stops, or at any rate is greatly reduced. A bitch will seldom receive the dog while bleeding is going on. The uterus begins to recuperate, new bloodvessels being formed. During œstrus also the Graafian follicles within the ovary become mature and the ripe ova are discharged. In the bitch the period lasts for about a week.

4. *Metœstrum* is the period which succeeds œstrus if conception has not occurred. In the bitch it probably lasts about a week, and during this time the generative organs become restored once more to that condition of quiescence which characterizes the anœstrous period.

If, on the other hand, conception occurs as a consequence of coition during œstrus, this period is succeeded by pregnancy, which in the bitch lasts from fifty-nine to sixty-three days. This is followed by a shortened anœstrum of about three months instead of five before another procœstrum is experienced. The periods of procœstrum and œstrus are frequently referred to collectively as the period of 'heat'.

In the bitch there are typically two œstrous cycles in one year, the heat periods occurring in spring and autumn, but among the smaller breeds the cycle may be shorter (*e.g.* four months), while there is considerable variation among different individuals. In one individual, œstrus generally recurs regularly after a constant interval, but this tends to become irregular in old age.

The mare, cow, sheep, and pig are polyœstrous, that is to say, the œstrous periods recur several times after short regular intervals, until the animal becomes pregnant or the sexual season is over. The short quiescent intervals between the heat periods are known as diœstrous intervals, as contrasted with the much more prolonged anœstrous periods. The short cycles are then called diœstrous cycles, each consisting of four periods (procœstrum, œstrus, metœstrum, and diœstrum). If, however, conception occurs, œstrus is followed by pregnancy as in the case of monœstrous animals. The number of diœstrous cycles that one animal may experience in the absence of the male (*i.e.* so that pregnancy cannot occur) differs widely, not only according to the species, but also according to the variety or breed, and the conditions to which it is subjected.

The mare generally comes 'on heat' for the first time in the year in spring, and if she has been pregnant, about ten days after foaling. She may then experience a succession of diœstrous cycles, each of three weeks' duration, until she is successfully served, or, in the absence of the stallion, until the autumn. The number of diœstrous cycles is not so great in the less domesticated types of horses (*e.g.* the rougher breeds of ponies). The procœstrum in the mare is much less severe than in the bitch, and probably does not last for more than about a day. External bleeding does not occur, but the external genital organs are usually slightly swollen, and the mucous secretion is increased. With the commencement of œstrus the mare may become very restive or even vicious. There is also a tendency to micturate more frequently, the urine being thick with mucus. In the presence of the stallion sexual excitement may be extreme, the mare continually protruding the clitoris (or female erectile organ). Œstrus itself does not generally last for more than a few hours, or at most a few days, but this is rare.

The cow, in a state of domestication, will breed at practically any season of the year, but is not usually ready to receive the bull until about six or eight weeks after calving, and not generally until after the calf is weaned, but this is by no means invariable. The diœstrous cycle is about three weeks, procœstrum and œstrus together lasting for approximately two days. External bleeding may occur during the procœstrum, but this is not usual. Œstrus is characterized by great sexual excitement, the cow bellowing and mounting its fellows.

The sheep shows very great variability in its sexual capacity. In its wild state it is probably monœstrous and breeds once a year. The Scotch Blackfaced sheep in the Highlands may experience two diœstrous cycles in mid-autumn. In the Lowlands, where the environment is more favourable, sheep of the same breed may have four or five diœstrous cycles in the absence of the ram. The majority of British breeds have a tupping season in autumn consisting of a varying number of diœstrous cycles, which tend to be more numerous where the conditions are more favourable. Summer is ordinarily occupied by an extended anœstrum, following lambing in spring. Certain breeds, however, may have young twice a year, this being the case among British sheep with the Dorset Horns of the south of England, and perhaps the Limestone sheep of Westmorland and Derbyshire. But the practice is discouraged as it tends to deteriorate the ewes. Probably the maximum sexual capacity seen in any sheep is that shown by the Merinos of New South Wales, which are capable of experiencing a continuous series of diœstrous cycles extending throughout the whole year. The duration of the diœstrous cycle in the sheep varies from about thirteen to eighteen days. The procœstrous processes are very abbreviated, so that the entire heat period does not last for more than about two days. External bleeding from the vagina is rare, but there is sometimes a mucous or sanguineo-mucous flow. Moreover, the uterus after heat contains much

pigment which is derived from blood set free from the congested vessels during the procœstrum. During œstrus, the ewe shows a characteristic restlessness and tends to follow the ram.

The sow is ready to receive the boar about a week after weaning her young, but sometimes does so during lactation. There may be two or even three litters in one year. The procœstrum and œstrus together last for three or four days, the complete diœstrous cycle being about three weeks. External procœstrous bleeding is unusual.

The procœstrum in animals is what corresponds to menstruation in the human subject, only in the case of the latter the process is far more severe. The menstrual cycle lasts four weeks and is comparable to the diœstrous cycle, but in the absence of pregnancy is recurrent throughout the whole year.

Heat does not take place in any animals after the complete removal of the ovaries. It has been shown recently that it is brought about probably through the action of one or more internal secretions elaborated by the ovaries and acting upon the other generative organs and upon the system generally. [F. H. A. M.]

Œstrus ovis, Linn. (the Sheep Nasal Fly).—Sheep now and again suffer to some extent

Sheep Nasal Fly (*Œstrus ovis*)

1, 2, Maggots; 3, puparium; 4, face; 5, fly, natural size; 6, fly, magnified.

from the presence of this fly, which deposits its eggs and young in summer on the nostrils, and the little maggots make their way up the nostrils and into the cavities of the skull, &c., where they grow until the following early summer, when they are an inch long (fig. 1; 2 a younger stage). They are ejected from the head during one of the violent fits of sneezing that they often occasion by the irritation they set up in the mucous membrane. They then enter the earth or get under a tuft of grass, and become hard brown puparia (fig. 3); from these the flies emerge during June and onwards, and may be seen in the chinks of walls under featherboarding and upon hurdles, &c., where sheep are folded, until Michaelmas. Large numbers of maggots may be found in the head of one sheep, when they cause vertigo or staggers, which may end in death. Affected sheep are often seen shaking their heads and stamping on the ground, at other times running about with their noses close to the soil; there is also a copious discharge of mucus (frequently bloody) from the nostrils. The maggots are first white, and eventually brown, with dark rough bands; they have two black hook-like mandibles on the head, and two spiracles at the tail. The flies are mottled grey, with large heads, the face ochreous (fig. 4, magnified); eyes brown; body silvery, mottled with black; the wings are transparent, with two oblique nervures; the legs ochreous.

Prevention and Treatment.—The sheep may be protected by placing on their nostrils some strong-smelling oil at the time the fly is about. A less troublesome plan is to place salt in boxes well covered with tar, so that the sheep get it on their noses when licking the salt. [J. C.]
[F. V. T.]

Offal.—The term 'offal' is often mentioned by butchers, and it may be well to define it.

Oxen.—The head, feet, lungs, heart, liver, stomach (all the four compartments), intestines, bladder, weasand (œsophagus), and melt (spleen).

Sheep.—The head, feet, pluck (lungs, heart, liver, and spleen), stomach, and intestines.

Calves.—The head and feet are generally sold together by the butcher, only the pluck being classed as offal.

Pigs.—The pluck and chitterlings (mesentery). The blood may be classed as offal in all animals. [T. D. Y.]

Oilcake.—This is a very indefinite term, and one which properly applies to cakes made from oil-yielding seeds. Its employment implies a cake which is useful on account of the oil which it supplies. Because, however, of the extensive use of linseed cake, and because of linseed being a typical *oil* seed, the term came to be attached to linseed cake, and was held to be synonymous with 'linseed cake'. It has been pointed out—under the art. LINSEED CAKE—how this application of the term came to lead to many abuses, and that it carried with it no guarantee whatever of the oilcake being one made from linseed only. The necessity of making the discrimination between linseed cake and oilcake was recognized in the Fertilizers and Feedingstuffs Act, linseed cake being the pure article, and oilcake a term which might mean almost anything else, but certainly not linseed cake as properly described. In the wider sense, oilcake may be applied to other cakes than those wholly or partly made from linseed. Cotton cake, rape cake, palm-nut cake, earth-nut cake, and many others may be called oilcakes, and even compound feeding cakes are so described. It is, however, a term which it would be well to drop altogether, for, as already pointed out, it is too often synonymous with 'impure' linseed cake. A linseed cake which would not pass the requirements of the Fertilizers and Feedingstuffs Act if described as 'linseed cake' could not be dealt with under the Act if described as 'oilcake', and provided it were free from admixture of worthless or harmful ingredients. Taken as a class, oilcakes are valuable in a diet because of their concentrated character. They are, as a rule, rich in albuminoids, and their addition to a diet of bulky food of carbohydrate nature and poor in nitrogenous bodies, raises the character of the whole diet. It is in this way that the true economy of concentrated foods comes in. [J. A. V.]

Oilcake Breaker. See art. Cake Breakers.

Oilcake Manures.—Generally speaking, the oilcakes are comparatively rich in constituents of manurial value, and especially in nitrogen, and have therefore a considerable value as manure. The following table shows approximately the percentages of manurial constituents contained in linseed and cotton cakes:—

	Nitrogen	Phosphoric Acid.	Equal to Tribasic Phosphate of Lime	Potash
	per cent.	per cent.	per cent.	per cent.
Linseed cake ...	4·7	1·8	3·9	1·3
Decorticated cotton cake...	6·9	3·0	6·5	1·8
Undecorticated cotton cake .	3·4	2·0	4·4	1·8

Decorticated cotton cake in particular is of high value as manure. It is specially rich in nitrogen, which is the most expensive constituent of manures to buy. As a rule these cakes are used as feedingstuffs, and it is only on exceptional occasions that they are used directly as manures.

Certain oilcakes and residues obtained after the extraction of oil from oilseeds are extensively used as manure. Of these the chief are rapecake and rapedust, and castor-oil cake and castor meal. Much rape which, owing to the presence of impurities, and especially of wild mustard seed, is unsuitable for use as food, and from this the rapemeal or rapedust used as manure is prepared. There are two processes by which the oil is removed from rapeseed. In one process the oil is expressed by hydraulic pressure along with a moderate amount of heat. The cake which is left still contains a fair percentage of oil. Much of the cake prepared in this way by pressure is used as food, though some of it is ground to meal for use as manure. The oil left in such cake has no value as manure, while it has a high value for other purposes. It is therefore to the interest of all parties that as much oil as possible should be removed from rape which is to be used as manure. Nowadays this is done by the use of a solvent such as carbon bisulphide, which dissolves the oil out of the seed. In this process the seed is not pressed into cake, but ground to meal and extracted by the solvent, which is afterwards recovered by distillation. The dry meal obtained in this way contains very little oil. Whereas rapecake contains about 8 per cent of oil, the solvent-extracted meal contains only about 2 per cent, but is proportionately richer in constituents of manurial value. Much of the rapemeal used as manure is prepared by the solvent process. Rapemeal contains about 5 per cent of nitrogen, about 2·3 per cent of phosphoric acid, equal to 5 per cent of tribasic phosphate of lime, and about 1·6 per cent of potash. It decomposes readily in the soil, and its nitrogen appears to be not much inferior in availability to the nitrogen of sulphate of ammonia. Ground rapecake or rapedust has been used as manure for a very long period and is very popular, especially in certain districts in England. Like all organic manures it is useful not merely in supplying nitrogen, phosphates, and potash to the soil, but in supplying humus, which improves the mechanical condition or tilth of the soil. In consequence of the favour with which rape is regarded by practical men as a manure, rapemeal and rapedust are dear manures. As a rule the nitrogen in rape costs much more per unit than the nitrogen in nitrate of soda or sulphate of ammonia.

Castor oil, like rape oil, is removed from the seed both by the old process of pressing the seed and by the new process of extracting with a solvent. The residue, which is unfit for use as a feedingstuff on account of its poisonous nature, is used as manure. Castor meal is not so largely used in this country as in India and some other warm countries, where it is one of the most important manures. Castor meal contains about 3·8 per cent of nitrogen, 1·9 per cent of phosphoric acid, equal to 4·1 per cent of tribasic phosphate of lime, and 1·0 per cent of potash. Like rape it readily decomposes in the soil, and forms a manure of good availability.

Other meals and residues from oilseeds are occasionally met with as manures. In all of them the value depends chiefly on the percentage of nitrogen which they contain. [J. H.]

Oil Engine. See the art. Gas and Oil Engines.

Oils, Essential.—Essential oils, which are usually obtained from plants, are volatile either alone or with steam. Some essential oils are pure hydrocarbons, but others are mixtures of hydrocarbons and some oxygenated compound such as ethers, phenols, aldehydes, or acids. Many essential oils deposit a solid—stearoptine—on cooling strongly, leaving a liquid portion, elæoptine.

Oils—Uses in Agriculture.—The oils met with in agricultural practice may be grouped into three classes, viz.:—

1. Fatty or Fixed Oils—those oils which in chemical character are similar to the fats (see art. Fats), and can hence be broken up readily into glycerine and fatty acids. *Examples*: linseed, cotton-seed, cod-liver, rape (colza), castor, soy bean, cocoanut, and olive oils.

2. Essential or Volatile Vegetable Oils—odorous oils existing in many vegetable matters, and differing from the fatty oils in that they can be distilled without decomposition and are not glycerine products. *Examples*: oils of aniseed, cumin, fennel, mustard, turpentine.

3. Petroleum or Mineral Oils—those oils which are obtained in different stages of the distillation of either crude petroleum or the crude oils obtained by the distillation of carbonaceous shale. *Examples*: petrol, naphtha, benzine (benzoline), paraffin oil.

Oils belonging to one or other of these classes are made to serve a great variety of purposes in agriculture, being notably used for feeding, lubrication, lighting, and power purposes, whilst individual oils are used for medicinal and other special purposes. It will be convenient to discuss the different uses under these heads.

Feeding Oils.—Oils are present to some extent in practically all the foods used on the farm, but notably in the foods commonly termed oil cakes (or meals), in linseed, rice meal, soy beans (and cake), maize, oats, and milling offals. Cod-liver oil also has in recent years been largely used in the rearing of calves as a 'cream substitute' or supplement to separated milk, and also for its medicinal qualities in the case of rickety or otherwise 'unthrifty' young stock.

All these oils are of the 'fatty oil' type, and represent the most concentrated form in which nutriment can be supplied to the animal, 1 lb. of such oils being commonly regarded as equal in nutritive value to nearly 2½ lb. of starch or sugar. With the exception of actively medicinal oils (*e.g.* castor oil) practically all the natural oils of the 'fatty' class may be supplied in moderate amounts as food to farm animals, especially when given without separation from the seeds, &c., in which they occur.

Oils belonging to the other groups have little or no direct feeding value, and therefore cannot be used as substitutes for the fatty oils. Essential oils are also present in small quantities in most foods, and are largely responsible for their aroma and palatability. These oils, by their presence, and consequent 'spicing' effect, may increase the general nutritive value of the foods containing them. The use of condiments is based upon this assumption, since it is to the presence of essential oils that the various materials used as condiments (see art. CONDIMENTS) owe their attractive aromas.

Lubricating Oils.—In the main only the coarser type of lubricant is required on the farm at present, but with the steadily increasing employment of complicated machinery for agricultural purposes a greater variety of lubricants will be required. At the present time the oils chiefly used as high-grade lubricating oils belong to the mineral or petroleum class, being obtained in the refining of crude petroleum or shale oil by distillation. In the course of the distillation a series of oils is obtained of steadily increasing boiling temperatures, those of low boiling-point being specially suitable for the working of oil engines, the intermediate members of the series forming valuable lamp oils, whilst the higher boiling and more viscous members include the most valuable lubricants. Of the 'fatty' oils, *sperm oil*—the oil obtained from the sperm whale—is the most highly valued lubricant, but is expensive, whilst to a less extent whale oil (train oil) and various other fish oils, neat's-foot oil, olive oil, palm oil, rape oil, cotton-seed oil, earthnut oil, &c., are employed. These 'fatty' oils are now used alone, the majority of the lubricating oils sold being either purely mineral oils or mixtures of mineral and fatty oils. The type of oil selected should vary according to the purpose for which it is required, a 'thin' oil, such as the finest mineral oils, being used for light bearings and high velocities, whilst an oil with more 'body' (*e.g.* a mixture of fine mineral oil and sperm oil) will be preferable for heavy machinery. For the lubrication of cart wheels and rough machinery greases are used. The best of these consist of mixtures of tallow and various oils made into a kind of imperfect soap with soda or lime and water. The coarse, dark-coloured greases are made from oily and tarry by-products, otherwise valueless, of various industries, *e.g.* distillation of coal tar, refining of oils, &c.

Lamp Oils.—The oils used for lighting purposes are now chiefly those of the 'mineral' class derived from petroleum and paraffin shale, and sold under a variety of names, such as paraffin oil, kerosene, petroleum, &c. In using mineral oils for lighting purposes greater care is necessary than with the fatty oils, owing to their greater volatility and the explosive nature of a mixture of petroleum vapour and air. The lamp must be so constructed that the oil reservoir cannot get hot, and further, to be perfectly safe the oil used should be of such a character that it may be heated to at least 100° F. without emitting sufficient vapour to form an explosive mixture (or 'flash') with air. This latter condition is not fulfilled by the oils sold under the names of petroleum spirit, petrol, ligroin, benzine, gasoline, or naphtha, which are therefore highly dangerous to use in ordinary lamps.

Oils used for Power.—With the introduction of the oil engine the consumption of oils on the farm has very greatly increased. The motive force in the oil engine is derived from the explosion of a mixture of oil vapour and air, so that only oils that can be fairly easily volatilized can be used for this purpose. For this reason the only oils that can be successfully used are the lower boiling petroleum oils referred to above (gasoline, petrol, &c.). The more volatile the oil used the more easily will the required explosive mixture be obtained, but the greater will be the dangers attending its storage and use.

The uses of oils referred to in the foregoing paragraphs are in themselves sufficient to indicate the great importance of these substances, but there are other uses, more limited to individual oils, to which brief reference must be made. Thus, in addition to its great value and use as food, *linseed oil* is the staple oil used in the making of paints and varnishes, being practically the only oil used for this purpose, although rosin oil (obtained by distillation of rosin) is often used as a partial substitute in cheap paints. Linseed oil owes its excellence for this purpose to its property of drying to a tough transparent film when exposed in a thin layer to air, this property being increased by boiling the oil with red lead or certain other substances ('driers'), the commonest of which are compounds of lead or manganese.

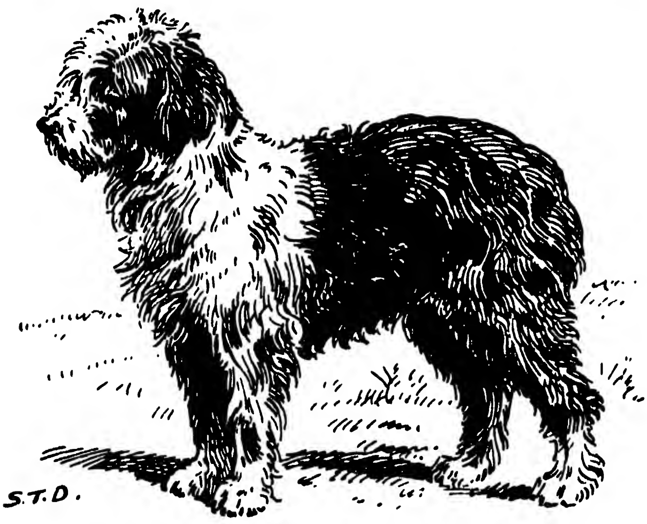
Another oil, the essential oil *turpentine*, is also used in the preparation of paints, with the object of making the paint thinner and also increasing the rapidity of drying. Turpentine is also used in the preparation of various varnishes, such as the oil varnishes, which consist of solutions of certain resins (copal, dammar, &c.) in a mixture of boiled linseed oil and turpentine.

The petroleum oils find a further use in the spraying of fruit trees, rose-trees, &c., for the

destruction of insect pests, ordinary 'paraffin oil' being one of the commonest ingredients of the spraying mixtures used for such purposes.

Reference must also be made to the medicinal uses of certain oils, notably linseed oil, castor oil, cod-liver oil, and turpentine. [C. C.]

Old English Sheepdog.—In general appearance the Old English Sheepdog is a picturesque-looking, powerfully built dog, rather inclined to be short on his leg—this effect is produced by the profuseness of his shaggy coat --and standing higher at the loins than at the shoulders, the result of this being that he possesses the roachbacked appearance of the Bulldog. Though he is a very ungraceful-looking animal when he walks, he improves a great deal when he begins to move quickly, and is in



Old English Sheepdog

fact a speedy and stylish galloper. His head is large, rather square, and well arched over the eyes, his muzzle being of a good length and very square-looking; the ears are small and lie flat to the sides of the head; whilst the neck is long, and slightly arched, but it appears shorter and thicker than it really is because of the profuseness of the hair upon it; the shoulders being long and laid well back. The body is short and big, with very muscular loins and nicely sprung ribs; the front legs are very heavy in bone, straight, and plentifully covered by hair, with rather small, round feet, which have extra thick soles, the hind legs being nicely bent at the stifles and muscular about the thighs. Dogs are rather taller and more robust-looking than bitches, about 24 in. being a fair height, the recognized colours being grizzle, blue, or grey, either with or without white markings. The colour of the coat regulates that of the eyes, which vary in shade, but one wall or china eye is regarded as a point to be secured. Finally, the coat though shaggy must be free from curl, and less profuse upon the ears than upon other parts of the body. [V. S.]

Old Red Sandstone.—This geological horizon, on which rests some of the best of our agricultural soils, is described in the art. DEVONIAN SYSTEM.

Oleander, an evergreen shrub with long narrow leaves and handsome flowers arranged in panicles. See art. NERIUM.

Oleomargarine.—Oleomargarine, or oleo, is the name given to the raw material used in the manufacture of margarine. See MARGARINE.

Oligocene System.—This system lies between the Eocene and the Miocene, and includes beds formerly classified with one or other of these systems. The beds are well developed in the Paris Basin, in northern Switzerland, near Vienna, and in north Italy.

In the British Isles, it is probable that the eruptions of basalt in northern Ireland and the Inner Hebrides continued during Oligocene times. In the Hampshire Basin strata occur, once classed as Upper Eocene, which correspond to the Oligocene of the Paris Basin. This fluvio-marine series has been subdivided into—

3. Hamstead Beds.
2. Bembridge Beds.
1. Osborne and Headon Beds.

All these names refer to localities in the Isle of Wight, where the coast-sections of the highly fossiliferous strata have been very fully studied. The northern lowland of the Isle of Wight is formed of Oligocene beds, which lie nearly horizontally, terminating in a sharp upfold against the ridge of Chalk that forms the backbone of the island. The beds are mostly loose sands and clays, but a pale-coloured freshwater limestone occurs in the Bembridge Beds; this is well seen between Headon Hill on the west and Bembridge in the north-east; it is over 20 ft. thick, and has been quarried for building-stone.

On the mainland, beds of the Osborne and Headon series spread westward from the mouth of Southampton Water to the Avon valley near Christchurch. They consist of clays and loams, which are exposed where the streams have cut through the overlying and infertile gravels. The beds have been denuded away on the north, so that the greater part of the New Forest area is formed by gravels resting on Eocene strata. [G. A. J. C.]

OLIGOCENE SOILS.—Both from their limited distribution and their inferior character, the soils resting on the Oligocene deposits of the British Isles are of very little agricultural importance. The similarity in the lithological character of the different series of this system, and the comparative uniformity with which the rocks occur in thin-bedded alternating layers of clays, marls,

shales, sands, and limestones, secure a fairly constant type of soil throughout the formation. The land is generally poor, cold, wet and unresponsive to agricultural treatment; the Hamstead Beds especially produce an inferior soil, which is occupied by unreclaimed wastes, pastures, and woodlands. At the outcrop of the Headon Beds in the New Forest area are to be found the best lands of that district. The 'country' rocks, however, are there sometimes covered to depths varying from 2 ft. to 8 ft. with gravels derived from the Chalk deposits. These gravels usually produce very inferior soils, and often, as in the country round Beaulieu, support barren heaths. As remarked above, some of the basaltic lavas which occur on the plateaux of Antrim, Mull, Skye, and the neighbouring islands, may be of Oligocene age, and, for the nature of the soils in these areas, see art. BASALT. [T. H.]

Olive, a small tree, *Olea europæa*, Linn., nat. ord. Oleaceæ, probably a native of Western Asia. It is well adapted to dry climates. Two forms are known in Europe: the wild spiny plant, the fruits of which are valueless, though the wood, especially that near the root, of both the wild and cultivated plant is greatly admired, being beautifully veined. But the cultivated unarmed plant with large oily fruits is of the greatest value. It yields two products, viz. olive oil and edible olives. The oil is obtained from the ripe fruits, the pulp of which (outside the stone) is pressed between rollers so adjusted as to squeeze out the oil without cracking the kernels. Pickled olives are prepared from the unripe fruits. These are first deprived of their bitterness by soaking in water containing a little lime and wood ashes, then bottled off in a fluid consisting of water, salt, and certain flavouring spices. [G. W.]

Omasum, or **Psalterium.**—This is the third compartment of the stomach of ruminants, and lies in the abdomen just behind the diaphragm or midriff, and between it and the rumen or first compartment. When full it is ovoid, somewhat curved, and depressed from above downwards. At one extremity it communicates by means of a small canal with the second stomach or reticulum, and at the other in a similar manner with the fourth or abomasum, the latter being the true digestive stomach. The omasum is filled internally with leaves or folds of mucous membrane, which follow the long axis of the organ, and has a peculiar appearance, to which the term 'manyplies' has been popularly assigned. These leaves are unequally developed, and attached by one border to the greater curvature of the cavity, while the other, free and concave, is turned towards the lesser curvature. The surfaces of these leaves are studded all over with papillæ or minute finger-like elevations, their function being to triturate and macerate the coarser particles of food before being passed on to the fourth compartment. Impaction of the omasum, or 'fardelbound' as it is popularly termed, is a somewhat common and extremely serious disease, and is chiefly met with in dairy cows. See IMPACTION. [J. R. M'C.]

One-horned Sheep, one of the races of domestic sheep found in Nepal, and distinguished from all other sheep by the coalescence of the two horns, which rise vertically from the forehead and curl back on to the nape of the neck. The coat of the one-horned sheep is woolly and tolerably luxuriant. The prevailing colour is white varied with brown or black, one or the other of these two colours always pervading the head and neck and parts of the legs. The ears are short and narrow but pendulous, and the nose is greatly arched, at least in the rams. [R. I. P.]

Onion, a hardy biennial, which has long been esteemed as a human food, and which is generally supposed to possess medicinal properties. It is widely cultivated, and adapts itself to the most varied climates. There are many varieties of onions, one of the most marked being the Potato Onion, which is much cultivated as a field crop in the south of England, the bulbs being planted in rows about 1 ft. apart on the shortest day, the crop being lifted on the longest. The Egyptian Onion produces clusters of bulbs in place of flowers. For garden crops it is usual to prepare the ground early in spring by deep digging, firming the soil well by treading, and sowing the seeds either broad-cast or in drills 8 in. apart. Another plan is to sow the seeds in autumn in a cold frame, and to prick out the seedlings in rows in April. Some gardeners raise seedlings in heat, and transplant them in the open border as soon as they begin to form bulbs. Or the seeds may be sown on a sheltered south border in September, where the young plants will grow slowly through the winter and be fit for transplanting in March. The best varieties for this treatment are White Spanish, Reading, and Tripoli. Spring-sown onions are most generally relied upon for a main crop of bulbs for storing. The seeds are sown in shallow drills about 12 in. apart, and when the seedlings are large enough they are thinned to about 6 in. apart, the 'thinnings', known as spring onions, being used in salads, &c. Onion beds should be kept free of weeds and the surface soil loose. When the weather is dry and the soil becomes parched, a watering should be given; as a rule, however, onions do not require to be artificially watered in this country. When the bulbs have reached full size they should be pulled up and left on the ground for a few days to dry. This should be done during dry sunny weather, turning the bulbs over once or twice to assist the ripening process. A tough brown skin is necessary to the proper keeping of the bulbs. Should they require to be taken under cover to dry, a shed, or, better still, an empty greenhouse or frame, may be used for the purpose. When the leaves and roots have withered, the bulbs should be cleaned and stored in a dry cool place, such as a loft, where they would be secure from frost. Or they may be strung together by their necks on a straw rope in the orthodox fashion. It must be borne in mind that onions require to be kept quite dry whilst they are in store for food, as moisture induces them to start into growth and then they are soon spoilt. The standard sorts

of onions for a main crop are Bedfordshire Champion, James's Keeping, Brown Globe, Reading, and White Spanish. The small-bulbed silver-skinned onions, such as White Egyptian, Queen, and Early Dutch, are preferred for pickling. Very large onions, such as are grown for exhibition, are mild in flavour and will not keep long; the best of them are: Ailsa Craig, single bulbs of which sometimes weigh over 3 lbs., Lisbon, Tripoli, and Giant Rocca. The Welsh Onion (*Allium fistulosum*) is distinct inasmuch as it does not form a distinct bulb, but is like the leek. There are white and red varieties. Its principal use is to furnish young onions for salads. [W. W.]

Onion. — Parasitic Fungi. — DOWNY MILDEW (*Peronospora schleideniana*) attacks seedlings, especially when moist. It is recognized by the leaves flagging, turning yellow, and becoming coated with a greyish velvety mould.

SMUT.—This is destructive, especially to young plants. It occurs as dark spots of sooty powder scattered over the leaves. The spores belong to a smut-fungus (*Urocystis cepulæ*).

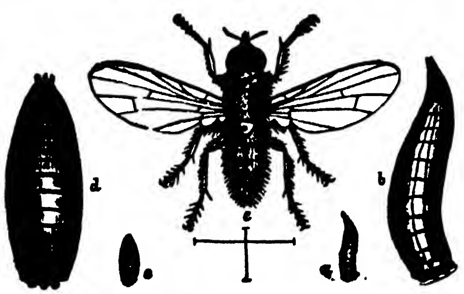
The following are mainly confined to the bulbs:—

SCAB (*Vermicularia circinans*). — Sometimes very abundant as black blotches on the outer scales; it renders the bulbs unsightly for market.

BULB-ROT is caused by the fungus which is so destructive to other bulbs (see HYACINTH—PARASITIC FUNGI).

Treatment.—When seedling plants are attacked they should be singled or thinned, all diseased plants being picked and burned. In soils where smut has been destructive, the next crop of onions may be protected by a dressing of ground quicklime (75 to 125 bus. per acre) applied just before sowing. Mildew in seedling beds may be checked by dusting with quicklime and sulphur. The onion crop should be sown each year in fresh soil, making the rotation as long as possible. [W. G. S.]

Onion Fly, a dipterous insect which generally makes its appearance in April or May,



Onion Fly (*Phorbia cepetorum*)[1]

a and b, Larva, nat. size and magnified; c and d, Puparia; e, Imago.

and which produces several broods during the year. It is about ¼ in. long, and is of an ashy-grey colour. The body is clothed with black bristles and hairs, and the abdomen has a row of black spots along it. The eggs are deposited by the female on the shoots of young onions or on the onion itself. The maggots which hatch out from the eggs eat their way into the onion and hollow it out, causing speedy decay. Pupation takes place in the ground or inside the onion. The treatment generally recommended is the winter application of gas lime, and the spring application of soot to the young plants. Additional precautions consist in applying a weak paraffin solution round the growing plants, in the early sowing of seed, and in lightly earthing-up the plants. [R. H. L.]

[1] Reproduced by permission of the Controller of H.M. Stationery Office.

Oniscus asellus (the Flat Woodlouse), one of the largest of our woodlice and the commonest. Its body is broad and expanded, and the colour is usually slate-grey with yellowish markings more or less regularly arranged. The antennæ of Oniscus have a three-jointed flagellum. This crustacean is also popularly called the 'slater', and in Kent the 'cow bug'. Their food consists of both animal and vegetable matter. They attack tender plants and seedlings, orchids and mushrooms, and do much damage in hothouses and frames. Soft fruits, as peaches and nectarines, are also damaged. They feed mainly at night, but to some extent in early morning. In mushroom pits they work all day and increase with great rapidity. Breathing by means of gills, moisture is essential for them. The eggs are laid at the beginning of summer and are retained in the brood pouch, where they undergo their development. The young are very similar to the adult, and remain together for some time with the parent. *Treatment.*—These woodlice may be trapped out-of-doors by filling old sacks with damp moss or long horse-manure. The creatures collect there and are easily destroyed. In hothouses they are best trapped by hollowing out potatoes and placing them with the hollow side downwards, the woodlice collecting beneath in daytime; pots filled with damp moss also attract them. Woodlice may be poisoned with white arsenic or mercury bicyanide, in which potatoes may be soaked as baits. Success has also been obtained under glass by fumigation with hydrocyanic acid gas. [F. V. T.]

Onobrychis, a genus of leguminous plants to which the Sainfoin belongs. See SAINFOIN.

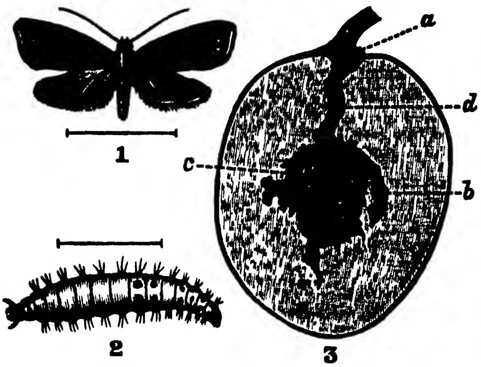
Ononis, the technical designation of Rest-harrow, a shrubby weed common to many districts. See REST-HARROW.

Oolite, and **Oolitic System.** This stratigraphical horizon is fully treated in the art. JURASSIC.

Oolitic Ooze.—This is a creamy-coloured mud found in the beds of oceans up to a depth of 2500 fathoms. It consists almost wholly of the calcareous tests of minute protozoa known as Foraminifera. Of these Foraminifera, Globigerina is the commonest.

Opadia funebrana (the Red Plum Maggot).—Plums, prunes, damsons, and wild sloes, &c., are often found to contain a red grub, which is the caterpillar stage of the moth called *Opadia funebrana*. The moth is about ½ in. across the expanded wings; the fore wings are

grey clouded with smoky-grey; at the anal angle is an indistinct ocellated spot, edged with shining pale-grey, enclosing four black dots; the hind wings are uniform in colour; when quite fresh the wings have a purplish-grey tint, and now and again blackish-grey. It occurs in June and July. The female places her eggs near the strig of the plums when they are small. The ova hatch in ten days, and the little caterpillars at once enter the fruit and tunnel down to the stone. The larva is chestnut-red in colour, with dull-yellowish sides; head dark-brown and shiny; the first segment



Red Plum Maggot (*Opadia funebrana*)

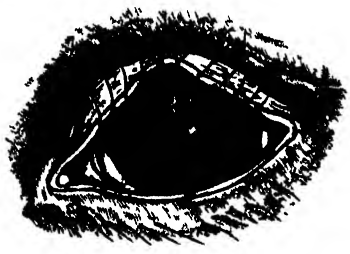
1, Plum fruit moth. 2 Larva 3, Plum attacked by maggot. *a*, Entrance hole of larva. *b*, Larva. *c*, Cavity eaten out round stone. *d*, Gallery to stone

yellowish-brown, the segments with four dark spots, the twelfth with a dark central area, and there are a few hairs. When full-grown they reach ⅝ in. in length. Their presence in the fruit becomes noticeable about the middle of August, when the attacked fruit often commences to fall. About the first week in September they reach maturity and then leave the fruit. If the fruit has fallen the caterpillars crawl up the trunks of the trees, or if still hanging, they crawl down the branches. On finding convenient shelter, such as under bark, moss, lichen, &c., they commence to spin up a small cocoon of whitish silk. There they remain all the winter in a dormant condition, and in the spring change to an amber-coloured pupa, dark-brown towards the posterior extremity. It has been noticed that where wall fruit is attacked the larvæ make use of the 'shreds' used for nailing against the wall as convenient places for pupation.

Treatment.—Where possible, all fallen fruit should be picked up and given to pigs, so as to destroy many of the larvæ before they escape. The larvæ may also be trapped as done for Codling Moth, namely by banding with sacking, the bands being on by the beginning of August. By spraying with arsenate of lead, with some adhesive substance as treacle when the moth is about, great numbers of the larvæ are poisoned before they enter the fruitlets. Poultry do good in an orchard by eating the larvæ as they escape from the fruit on the ground. [F. V. T.]

Open Joints.—Open joint is one of the most serious accidents that can befall an animal. Any joint may of course be punctured and permit of the escape of synovia, which is what is meant by open joint, but those most exposed to the risk are the knee (from falls), the elbow, stifle, and hock, the latter injuries too often being inflicted by vicious or playful companions. Although a complicated joint, the knee is most easy to treat, as the animal can be made to stand with the carpus locked, while with a wounded hock or stifle the same degree of restraint is impossible. It is important to recognize joint oil, but the temptation to use a probe must not be yielded to. Two opposite methods of treatment have been found successful: cold irrigation continuously applied for several days and nights, and a sharp fly blister. The latter causes such swelling of adjacent tissues as to close the orifice. If air has gained access, the discharge takes on a saffron hue; the patient suffers great pain and much constitutional fever, and should be slung and fed from a nosebag or bucket with laxative foods, linseed oil being given to ensure the bowels being kept open. Among the most serviceable antiseptics may be named oil of cloves, creosote, carbolic acid, and perchloride of mercury. A paste of whiting and white of eggs is sometimes applied until a crust forms and closes the wound. A long period of nursing and subsequent rest is needed, and more or less permanent enlargement will follow; but many horses recover, prove useful, and remain sound for work. [H. L.]

Ophthalmia.—Inflammation of the membranes covering the front of the eye—the conjunctiva and cornea—is not uncommon in animals, and may be caused by the lodgment of foreign bodies, as flies, hay seeds, the lash of the whip, &c. Simple ophthalmia from such causes is usually transient, and no structural changes



Recurrent Ophthalmia

Eye of Horse showing an angular condition of the upper lid, the result of a succession of attacks of Specific Ophthalmia.

follow. The lids are observed to be swollen, tears overflow, great sensibility is displayed, and the animal fears the approach of man, or its fellows. If caused by a foreign body, the offending substance should be sought and removed. With a 5-per-cent solution of cocaine thrown upon the suffering member, an examination can presently be made, and a camel-hair pencil may serve to remove the object; after which, warm fomentations will assist in restoration. An inflamed eye should be protected from strong light, and a cool dark box will also prove less attractive to

flies. Following on the acute inflammatory stage, a cloud or opacity of the cornea is often present, and its absorption may be promoted by a sulphate of zinc lotion, of the strength of 2 gr. to each ounce of distilled water. An aperient dose is also advisable. Besides the simple forms of inflammation of the eye, there are so-called 'blights' or infectious ophthalmia, which afflict cattle, and still more often sheep, in certain seasons. These should be treated with antiseptics, as a 10-per-cent boracic acid lotion, or one in two thousand perchloride of mercury, and the diseased as well as suspects segregated. The opacity which follows needs the same measures as have already been advocated. Periodic ophthalmia, or recurrent inflammation of the internal structures of the eye, is peculiar to equines. It has been called moon-blindness on account of its recurrence at something like regular intervals, and it invariably ends in blindness, although repeated attacks may be endured before that result is reached. Its cause is obscure, but it is fortunately less frequent since better hygienic conditions have been general. The symptoms are much like simple ophthalmia, only more severe, and the globe being retracted, gives the opening a puckered or three-cornered appearance—a lasting sign after apparent recovery, and well known to veterinary examiners. *Treatment* consists in a dose of aloes, soothing fomentations, and such measures as have been already recommended for simple ophthalmia.

[H. L.]

Opium is the inspissated juice obtained by scratching the unripe capsules of *Papaver somniferum*, Linn., of the nat. ord. Papaveraceæ. There are two varieties of the plant, that may be spoken of as red-flowered and white-flowered, and these afford the two chief grades of opium, viz. the medicinal (produced chiefly in Asia Minor), and the edible, used in smoking, eating, &c. (grown mainly in India and China).

The opium poppy, therefore, may be said to be grown in three chief areas: (1) Asia Minor, Egypt, and Persia; (2) India; and (3) China. The first affords the bulk of the medicinal opium (Turkey in Asia and Turkey in Europe), while the second and third grow the smoking-opiums. China itself is the chief producing country (in point of quantity) for smoking-opium; but it is generally affirmed that the Indian drug is very much superior to the Chinese—is in fact, so to speak, the champagne of the luxurious. After the removal of the opium the capsules are allowed to mature, and the seeds are then collected (which now contain no trace of opium) on account of the sweet edible oil which they yield on cold expression (see OILS).

In India, land in the immediate vicinity of the homesteads is selected for poppy cultivation, on account of its being higher, usually more richly manured, and more easily supervised. A dark sandy loam is preferred, but even the best of soils have to be very highly manured, and penning sheep and goats in the field is viewed as one of the most satisfactory of available methods. Nitrate of potash is the most approved of mineral manures. The selected plot is ploughed at intervals of ten days, and for two months prior to the middle of October, when it is partitioned off into oblong beds of 6 to 8 by 4 ft., with narrow paths or water channels between—a system adopted for convenience of weeding, watering, and subsequent harvesting. The seed is specially selected from extra large and highly productive capsules, and a change of seed from one locality to another is fully recognized as desirable. Before sowing, the plots are well watered, and the surface clods thoroughly pulverized and the surface levelled. Six pounds of seed are required for a *bigha* of land (3025 sq. yd.). The seed is often soaked in water or some liquid manure the day before sowing. About a week after, the plants shoot up, and when 6 in. high are weeded and thinned until they are 6 to 8 in. apart each way. Irrigation commences as soon as the plants appear, and is continued at regular intervals up to the maturity of the capsules; but stagnant water is injurious. In about 75 to 80 days from sowing, the flowering is complete. The petals, which are four in number, are carefully removed the third day after expansion, and are preserved. These constitute the 'flower leaves' used in casing the manufactured opium. Some 8 to 10 days after the removal of the petals, the capsules are ripe for being scratched. In Bengal, therefore, the opium begins to come into market by the end of January, and is continued until the middle of March, or in more northern tracts (such as the United Provinces and Panjab) may not be completed till April, and in the hills (where the growing season is much later) not till June. The incisions made on the green capsules are from below upwards, more or less perpendicularly along the length of the capsule. Each capsule is lanced in this way three or four times at intervals of two or three days, and with a special knife consisting of four sharp blades tied together in such a manner as to prevent them cutting deeper than, say, half the thickness of the capsule wall. The milk that oozes from the scratchings is next morning scraped off with a small trowel-shaped scoop of thin iron. This, after passing through various stages of purification and concentration, is the opium of commerce. The average yield from each set of scarifications is about 10 gr., and each plant after five to eight scratchings may yield 75 gr. in all. In Bengal the opium is collected pure (the chief adulteration being the removal of portions of the capsules along with the dried juice), and is sent to the Government factories to be manufactured, and sold by auction as the demand arises. In Western and Central India the crude Malwa opium is at once placed in a vessel containing linseed oil—a practice justified from the desire to prevent too rapid evaporation. This system can hardly, however, be described as one of adulteration, since it is known and authorized by the trade.

The Indian production of opium is about 140,000 cwt. (or, say, 15½ million lb.), and consists roughly of 65,000 cwt. produced in the United Provinces, 55,000 cwt. in Bengal, and 20,000 cwt. the so-called Malwa supply. Canton is the chief single market for the Indian exports; but to that has to be added the supplies drawn

by other Chinese ports, by the Straits, and by other foreign countries—Great Britain, for example, taking on the average, say, 446 cwt. a year.

The total Indian revenue from opium is now about 4½ million pounds sterling net, of which under one million is the excise duty on local consumption, and the balance derived from foreign exports. The Indian consumption is highest in damp malarial tracts, where the use of opium is universally believed to be beneficial. Moreover, with the people of India the danger of accumulative action (which is said to exist in China) appears to be practically unknown. A very large number of persons take a daily allowance throughout life, and some of the strongest and most healthy communities, such as the Sikhs, are habitual opium eaters. The British supply of opium seems to be expanding: in 1903 the total came to 522,320 lb., and in 1907 it amounted to 850,398 lb., valued at £535,365. The chief (or what might be called normal) supply is that already alluded to as coming from Turkey; but recently there has been developed a new grade, namely from Persia, either direct or via Hong-Kong, which in 1907 amounted to 377,307 lb., or more than one-third of the total demand. This is the more surprising, since according to Indian experience the finer grades of the Indian drug are quite suited for all medical purposes, and are so used universally in that country.

[G. W.]

Options and Futures in Corn.—Sales of corn, cotton, and a few other commodities for future delivery, were originally known as 'futures'. An 'option' may be defined as an agreement whereby one party secures the option of selling to or buying from another party a given quantity of a certain commodity at a future date or within a future period at a fixed price. Practically an option is the same as a future, and the two terms have been used indiscriminately for time bargains; but the novelty of an option when it was introduced consisted in the fact that the seller did not necessarily possess, or the buyer receive, the article nominally sold, a settlement being often effected by the payment of the difference between the price fixed and the market price of the commodity at the time of the maturity of the contract, or earlier if the parties concerned agreed to settle sooner. In 1876 or thereabouts the option system came into use in the United States in connection with wheat, maize, and two or three other commodities. It soon gave rise to gross abuses, being used as a purely gambling arrangement, under which no delivery was contemplated or made.

It must be explained that no particular lot of wheat or maize is the subject of an option contract, but only a definite quantity of a particular grade. Even if a particular lot were specified, it could be nominally transferred fifty or a hundred times before an option of some months' duration matured. Wherever the option system is in regular operation, there is a daily or weekly settlement through a clearing house, and the daily or weekly changes in price have to be settled between each pair of men concerned in an option. Therefore it is obvious that, even if a particular lot of wheat in a certain elevator were the subject of an option contract, only the first seller and the last buyer would be concerned in moving the grain, all intermediate buyers and sellers being simply gamblers in price differences.

There is much difference of opinion as to the effect of option speculation upon the grain trade; but farmers in the United States have always been strongly opposed to it, and have made efforts to have it suppressed by legislation. They describe it as 'wind-selling', declaring that its tendency on the whole is to lower prices; and although it greatly facilitates the manipulation of 'corners', which force up prices for a time, it is to be observed that this almost invariably takes place after farmers have sold nearly all their grain.

[W. E. B.]

Orache, an annual weed of arable ground, belonging to the Mangel family, whose seeds are much sought after by poultry. See ATRIPLEX.

Orange, the fruit of a small tree or bush (*Citrus Aurantium*, Linn., nat. ord. Rubiaceæ). There are many varieties or special races known in the trade and to the cultivators. In India, for example, there may be said to be four chief kinds of sweet oranges: (1) The *santara* is the orange of all the important plantations or 'orange groves' of India. It is undoubtedly the best orange in India, and is characterized by its yellow colour and loose skin, or jacket as the rind is called. (2) The *keonla*, or common (the village) orange, found all over India—a much inferior fruit to the *santara*, though some of the stocks classed as *keonla* oranges are often of good quality, while some of the *santaras* are at times of a low grade. The *keonla* oranges are of a dark colour, and have a thick rind, which is usually difficult to separate. (3) The Malta or Portuguese 'blood oranges', which are very dark (rose-orange), with a very rough and firmly adherent rind, and have the flesh almost purple or mottled in colour. Lastly, (4) the Mandarin or Tanjerine oranges, small, greatly flattened, and very sweet oranges, with the rind so loose that it often separates spontaneously.

The above classification may be said to be applicable to all countries, here and there other special forms being met with. The Saint Michael Orange, for example, one of the most highly prized in the European markets, belongs doubtless to the *santara* series, while the cheaper and commoner sorts sold in Britain would all fall under the *keonla* grade. Special forms may be mentioned, such as the 'sweet-skinned' orange, the rind of which is thick, soft, and sweet; the *kumquat* of China and Japan, which is eaten whole, preserved in syrup; and the 'Bergamot', which has both the flowers and young fruits so richly flavoured that they are employed in the manufacture of an essence. Loose-jacket oranges are preferred for local consumption; but since they do not travel well, firm-rinded forms are specially grown for the export market.

The orange may be grown on any soil so long as it is of fair quality, deep, and well-drained,

but preferably a soil rich in lime seems best suited. Perhaps no other fruit tree responds more readily to generous treatment. It is moreover fairly hardy, for while a native of the Tropics it may be grown in the warm temperate tracts (such as the south of France), provided the winter's frost serves to kill only the younger wood. But the yield rapidly decreases on leaving tropical areas, and conversely the fruits become not only more abundant, but of a larger and more luscious nature, in warm moist localities. Propagation in most countries is by seed, though special forms are budded or even grafted, but these do not come up true, and hence the false opinion that the seeds of the orange do not transmit the special properties of the fruit. Moreover, seed propagation is said to retard the commencement of fruiting, but to extend the bearing powers of the plant. The seeds are sown in nurseries, but must be taken from fresh fruit, since the dried seeds rapidly lose their vitality. They are deposited 3 to 4 in. apart, and in rows 8 to 10 in. apart. The soil of the beds must be deep, so as to allow of the liberal production of the taproots, which in transplanting should be taken all possible care of. The plants may be removed to their permanent positions when a year or two old, but this must be done at the commencement of the rainy season. If it be intended to form a special plantation the trees may be arranged in rows 25 ft. apart each way (70 to the acre), and as they do not come into bearing for six to ten years it is a good plan to interplant the rows with some catch crop such as melons, beans, brinjals, &c., the deep cultivation for which is beneficial; but since the orange is a surface feeder, catch-crop planting too near the trees, and even tillage, except of the most shallow kind (such as would be given in weeding), must be avoided. But if it be not intended to form 'orange groves' the trees may be planted by roadsides or in odd corners, or as wind hedges through tea or coffee plantations; but they cannot be made profitable if grown under shade—no fruit tree demands more open air and direct sunlight than the orange. Manuring with farmyard or green crops will greatly improve the yield and quality. So also pruning is indispensable—all superfluous growth must be annually removed, also all exhausted and dead wood. The lateral branches low down on the stem should be systematically removed, for, as the plants grow, they should be trained to form clean stems and methodical branching. The yield varies greatly according to soil and climate, viz. from 400 to 14,000 oranges per tree, and if well cared for, the trees may continue to bear for forty years. In 1907 the United Kingdom imported oranges to the extent of 6,120,185 cwt., valued at £2,454,569, of which Spain alone contributed a quantity valued at £1,994,339, Turkey in Asia at £226,429, Italy at £194,576, and the West Indies at £72,099. [G. W.]

Orchard, an enclosure for the cultivation of fruit trees, originally apples for the production of cider, but now planted with various kinds of fruit trees and bushes. The orchard proper is enclosed by a wall or other fence to provide shelter to the trees. The site should be one favourable to the growth of the particular kinds of fruit desired; generally lowlying situations are less favourable than those at an elevation of from 300 to 400 ft. above sea level and where the land slopes to the south or south-west. A northerly or easterly slope is less favourable for the ripening of wood and fruit, and in the spring for the safety of the flowers from cold winds and frost. Shelter from strong winds should always be provided, either in the form of belts of trees, such as poplars, or, better still, pines. The soil best adapted for fruit trees generally, is a deep loam resting on a gravelly subsoil. Its physical condition is important. Adequate drainage of the agricultural pattern ought in the first instance to be provided wherever ample natural drainage is not present. Where such trees as Oak and Ash grow well, the soil is almost certain to be suitable for fruit trees. Land that has been under cultivation for a considerable period as farm land will probably be in the right condition for planting, if before the trees are set the soil be well trenched. When the trees are to be planted 30 ft. apart and bush fruits between, it economizes labour to thoroughly trench a piece of ground 2 yd. square for each tree, and if the soil is not rich, placing a good layer of farmyard manure in the bottom spit of soil at the time of trenching. When the trees are planted they should be supported by a stout stake, and if the orchard is to remain under grass, these two square yards, in the centre of which the young tree is planted, should be kept open and free of weeds. Grass, if allowed to grow about young fruit trees, has a crippling and starving effect on their growth. Where sheep or other animals are to be grazed in the orchard, the trees must of course be adequately protected by iron or wood guards. Standard trees are best for orchards, and should be on the free or crab stock, which encourages free growth and longevity, although it delays the fruiting period for several years compared with trees on the paradise stock.

There are several plans for the arrangement of the trees in an orchard. We give here four which show the positions for the trees, &c.: (1) An orchard for standards only; (2) for standards and dwarfs alternately; (3) for trees and bushes; and (4) for trees, bushes, and vegetables.

The operations of pruning, spraying for insect and fungoid pests, grease banding, and harvesting and storing the fruit, are dealt with in other parts of this work.

The formation of an orchard on successful lines does not begin and end with the preparation of the land and the planting of the young trees. The attention of skilled cultivators must be provided continuously. Failure in attempts to grow fruit on a large scale is very frequently brought about by the neglect of some important operation in the initial stages of the venture. It is impossible to say in what form a reverse will first show itself. It may be insects or fungi, the attack of rabbits, hares, mice, or other vermin, or drought; only the skilled observer

can detect these and prevent them from assuming disastrous proportions. For this reason the cultivation of fruit on an extensive scale can only be successful under skilled supervision, and the performance of the various operations by competent workmen.

Old orchards, where the trees are mostly worn out or suffering from canker, can only be made profitable by drastic treatment; generally it is most expedient to stub out root and branch all the old trees, trench and manure the soil, and replant with healthy young trees of the best and

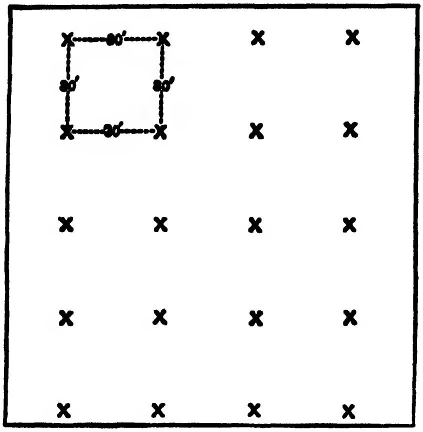


Fig. 1.—Orchard for Standards only (Square System)

X = Standard Fruit Trees: 30 feet × 30 feet.

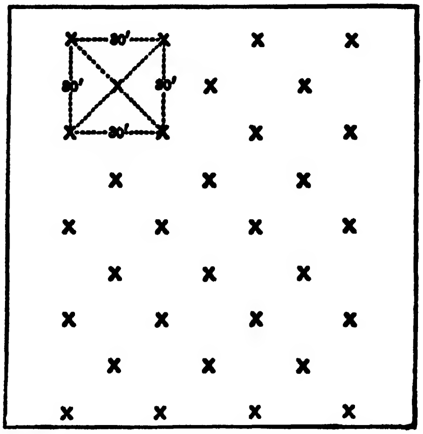


Fig. 2.—Orchard for Standards and Dwarfs (Quincunx System)

X = Standard or Dwarf Fruit-trees (or Standards and Dwarf alternately).

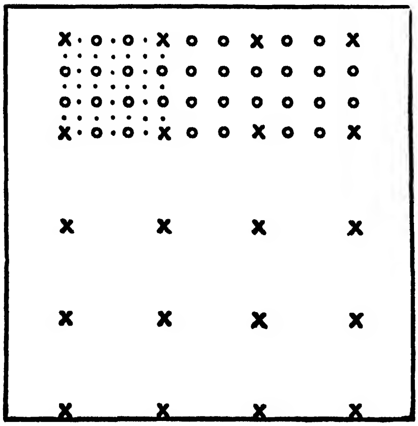


Fig. 3.—Mixed Plantation for Trees and Bushes

X = Standard fruit-trees: 30 feet × 30 feet. O = Dwarf apples, &c., at 10 feet. • = Gooseberries and currants at 5 feet.

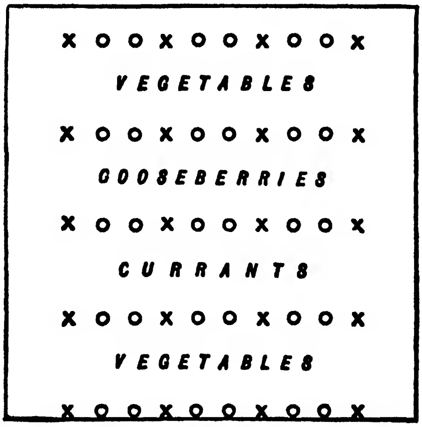


Fig. 4.—Mixed Plantation for Trees, Bushes, and Vegetables

X = Standard fruit-trees: 30 feet × 30 feet. O = Dwarf apples, &c., at 10 feet. Intermediate spaces: vegetables and bush fruits alternately.

PLANS OF ORCHARDS (Scale: 60 feet to 1 inch)

most suitable varieties. In some cases, however, the trees, owing to neglect, have got out of condition, and may be restored by skilful treatment. Apples and pears are often renovated by a severe application of the saw and pruning knife, or they may be beheaded and the stems grafted with better sorts. All large wounds should be dressed with tar immediately after cutting operations. The poor condition of the trees in old orchards is often due to there being grass turf over the roots, and improvement in their health soon follows the removal of the turf from a space 6 or 8 ft. in diameter around the base of the tree, and covering the soil with a thick mulch of stable manure, applied annually until the trees have regained their vigour.

Where liquid manure from the drainings of farmyard heaps is available, it should be applied to the roots of weak fruit trees and bushes, the best time to apply it being April and May, when

active growth is commencing. The best artificial manures to apply as a dressing to orchards in spring are superphosphate and sulphate of potash.

Young trees of the right size and kind can only be secured either by raising them in the home nursery or by purchase from dealers of repute. To plant on an extensive scale trees that are doubtful with regard to stock and correctness of name is not a wise policy. It is better to purchase the best sorts from the most reliable dealers, who may be advantageously consulted as to the selection of sorts for the situation to be planted. Young apple, pear, plum, and cherry trees cost from about 1*s.* each for Dwarf Maidens to 4*s.* or 5*s.* for pyramids and bushes of 3 ft. to 5 ft. in height, and from 7*s.* 6*d.* to 10*s.* 6*d.* for extra large fine trees. [W. W.]

Orchard Grass, more commonly known as Cocksfoot. See COCKSFOOT.

Orchestes fagi (the Beech Orchestes), a small culicid beetle also known as the Beech Leaf Miner. During recent years it has become very harmful. Some years it damages the foliage so much that it looks quite brown, and appears as if frost-bitten or browned by wind bruising. Besides forest trees the beetles are also said to attack raspberries and cherries. The beetles prefer large trees and those in sheltered places as a rule, but even on the top of 'downs' they may suffer from its attack. The life-history is fairly well known. The beetles hibernate under fallen leaves, in crevices in bark, and at the foot of trees. They appear in the first warm days of spring and feed upon the buds. The eggs are laid under the young leaves near the midrib. The larvæ hatch in a few days. They at once tunnel into the parenchyma and form small twisted or sinuous galleries about $\frac{1}{12}$ in. across; the larvæ proceed in the direction of the apex of the leaves. When the tunnel is about $\frac{3}{4}$ in. long it suddenly swells into a large area over the leaf, giving it a blistered appearance. The larva when full grown reaches $\frac{1}{4}$ in. in length, and is creamy-white, flattened, and with a brown head. Pupation takes place at the edge of the blister, usually the outer edge, the pupa being enveloped in a delicate cocoon. From the pupæ the beetles hatch in June. They are about $\frac{1}{8}$ in. long, black in colour, with grey pubescence when fresh; the rostrum is characteristically bent under the body; legs bright-brown, and also the antennæ; hind legs with the femora thickened, and armed with an apical spine. They fly well and are very active, jumping readily by means of their peculiarly formed hind legs. The mature beetle also causes damage by eating holes in the leaves, piercing the seed capsules, and devouring the flower buds.

Treatment. — The only method of checking them is by collecting and burning the dead leaves beneath the trees in winter, and by encouraging insectivorous birds. Special trees in parks and gardens could be saved by arsenical spraying. [F. V. T.]

Orchestes quercus (the Oak Orchestes). —The beetle is reddish-yellow, covered with grey hairs, and with black eyes; the posterior femora have serrations. It attacks the oak in a similar way to the former on the beech. It is said to be commonest on suppressed oak undergrowth, under Scots Pine, &c., but also attacks old trees. [F. V. T.]

Orchids.—The nat. ord. Orchideæ comprises about 350 genera and over 5000 species of the most varied characters, and yet certain of these characters are so well marked that orchids are easily distinguished from all other plants. They are widely distributed in temperate and tropical regions throughout the world, and in some countries, for example India, orchids constitute the largest order of flowering plants.

For many years orchids, owing to the singular beauty and other attractions of their flowers, have occupied an important position among garden plants. At first there was some difficulty in hitting upon the right conditions for their cultivation. Messrs. Loddiges of Hackney began to cultivate them for sale about the year 1812, and subsequently Sir Joseph Paxton among others took up their cultivation at Chatsworth with wonderful success. By the middle of the 19th century a considerable number of collections of orchids had been formed in this country. Nurserymen dispatched collectors to search for and bring home living plants of the most striking kinds; and so successful were they, that in the course of another thirty years the cultivation of orchids had grown to be not only a popular art, but one of considerable commercial importance. There are now in Europe many large establishments devoted to the cultivation and breeding of orchids; the flowers are produced in enormous quantities even by market nurserymen; so that it might be said with good reason that never in the history of gardens have any plants held so important a position among those grown for purely æsthetic reasons as orchids now do. In recent years much has been done to simplify the breeding of orchids from seeds produced by cultivated plants, and seedlings are now raised by the million. Many hybrids have been bred, some of them of such great beauty that they have been sold for prices equal to those of racehorses and celebrated works of art.

The most popular genera of orchids are * Cattleya, * Cœlogyne, * Cymbidium, * Cypripedium, Dendrobium, * Epidendrum, * Lælia, * Lycaste, * Mas-devallia, * Maxillaria, * Miltonia, * Odontoglossum, * Oncidium, Phaius, Phalanopsis, Stanhopea, Vanda, and * Zygopetalum. Some species of those genera marked with an asterisk may be grown in a greenhouse, the others require tropical conditions. [W. W.]

Ordnance Survey Maps.—The maps published by H.M. Ordnance Survey, a body now connected with the English Board of Agriculture and Fisheries, form the basis from which every accurate representation of the British Isles has been derived.

The Ordnance Survey now seeks to maintain for every part of our islands a map of reasonably modern date on the scale of one inch to one mile (1:63,360). The older sheets of large size and various price have been abandoned, and uniform sizes have been adopted as follows: England and Wales, 18 in. × 12 in., 1*s.* each

sheet; Scotland, 24 in. × 18 in., 1*s.* 9*d.* each; Ireland, 18 in. × 12 in., 1*s.* each. Useful composite sheets, on thin paper, have also been prepared, with some well-known town in the centre of each, price 1*s.* 3*d.* These frequently save the purchase of several adjacent sheets of the ordinary map.

The conditions and dates of publication, however, have led to a lack of uniformity in the mode in which the surface-features of the country are represented. Many Irish sheets had, until recently, no indications of hill and valley, other than those afforded by the courses of the streams and by a few figures indicating heights above sea-level. The older English sheets, again, exhibited hill-shading, but gave scarcely any indication of the actual heights. Other sheets, again, notably those of the central Scottish highlands, may be procured either with contour-lines at intervals of 100 up to 1000 ft. above Ordnance Datum, and at intervals of 250 ft. thereafter, or in a hill-shaded edition, with heights indicated at important points. In a few English and Irish sheets, contour-lines and hill-shading have been attempted on the same sheet; but this is unsatisfactory unless the contours can be indicated in colour. Latterly, numerous sheets have been issued with black groundwork, brown roads and hill-shading, green woods, and blue water, which fully equal the corresponding and justly popular maps of continental Surveys.

Reduced maps on the scale of half a mile and a quarter of a mile to one inch are now being published, on the colour-scheme given above. The agriculturist, however, will derive still greater benefit from the map which is the basis of all these, viz. that on the scale of six inches to one mile, published at prices varying from 1*s.* to 2*s.* 6*d.* per sheet. This was originally a county map; but the blank spaces thus left on certain sheets are now being gradually filled in. This map naturally varies much in style and detail in different areas; the sheets of the county of Donegal, published about 1839, with contour-lines at intervals of 25 ft., and hill-shading also in craggy places, represent the original ideal type, which proved too elaborate and expensive. Some of the older sheets, however, remain without any contour-lines whatever. The zincographed sheets now issued fulfil all topographical requirements on lands from sea-level up to 1000 ft. This six-inch Survey represents field-boundaries, footpaths, wells, and even the condition of the land when the map was made, whether park, garden, wood, or farm-land. It is now supplemented by a further series of sheets on the scale of 1 : 2500 (approximately 25 inches to 1 mile), price 3*s.* each. These are especially useful near towns, and roads, houses, &c., are indicated in colour. [G. A. J. C.]

Ordovician. For a description of this geological system the reader is referred to the art. SILURIAN.

Oregon Pine. This conifer is described in the art. DOUGLAS FIR.

Organic Chemistry.—The classification of chemical compounds into two great divisions—Inorganic and Organic—was originally intended to distinguish mineral substances from those of animal or vegetable origin. Up till the early part of the 19th century it was thought that organic substances could only be formed as the result of animal or plant life; but this view is no longer held, since many typical organic substances have been prepared in recent years in the chemical laboratory, and are found to be identical in properties with the naturally occurring compounds. The term 'organic chemistry' is still retained, however, but is now used as a matter of convenience to designate the enormous class of compounds which the element carbon forms with oxygen, hydrogen, nitrogen, and a few other elements. The simplest compounds may consist of only two elements, *e.g.* marsh gas —a compound of carbon and hydrogen; or cyanogen—a compound of carbon and nitrogen. Most commonly, however, the three elements carbon, hydrogen, and oxygen are present, as in the well-known substances sugar, starch, cellulose, and many other bodies found in plants. The next commonest element is nitrogen, which is found in both vegetable and animal organic matter. In addition to the elements already mentioned, certain animal and vegetable substances also contain sulphur and phosphorus.

Organic substances can easily be distinguished from inorganic in the following manner. When heated they readily decompose and break up into volatile gases or vapours, a residue of carbon being left which gradually burns away if the heating be continued. If any inorganic matter is present, it will be left behind as an ash after the organic matter has all burned away.

SOURCES OF ORGANIC COMPOUNDS.—(1) Plants and animals; (2) petroleum wells, such as those of America and Russia; (3) by the distillation of 'coal tar'; (4) from the dry distillation of bituminous shale.

1. From plants and animals many organic compounds are obtained by suitable processes of extraction. From plants in particular we get such well-known substances as the sugars, starch, cellulose; the vegetable oils, organic acids, essential oils, turpentine, rubber, and many substances of great physiological activity such as the alkaloids.

2. The crude petroleum obtained from the American and Russian oil wells consists of a mixture of many substances, and is separated into various fractions of different composition and varying degrees of volatility by the process of 'fractional distillation'.

3. When coal is strongly heated in the absence of air, as in the manufacture of coal gas, a great variety of gaseous, liquid, and solid volatile products are obtained, a non-volatile residue of coke, together with the inorganic matter present in the coal, being left behind in the retort. The products of the distillation are passed through coolers in which the less volatile constituents condense, the gas passing on to the gasholder. The condensed liquid separates naturally into two layers: the upper one is known as 'gas or ammoniacal liquor', and is the chief source of the ammonium compounds of commerce; the lower layer is the thick, dark, oily liquid known as coal tar. The coal tar is fractionally distilled

and separated roughly into pitch and various light and heavy oils. The various fractions obtained in this way serve as the starting-point for the preparation of many highly important organic substances.

4. In Scotland by the dry distillation of bituminous shale we get inflammable gases, ammonia, oil, and coal tar. By fractional distillation of the oil we get naphtha, burning or paraffin oil, light mineral oil, and paraffin wax.

Symbols and Formulæ.—The chemical elements are generally represented by symbols, usually the first one or two letters of the Latin name of the element, and by writing these symbols alongside each other we can easily express what elements any given compound contains. The symbols of a few of the more common elements are given in the following table:—

Element.	Symbol.	Atomic Weights.
Aluminium	Al	27
Barium	Ba	137
Calcium	Ca	40
Carbon	C	12
Chlorine	Cl	35·5
Copper	Cu	63
Hydrogen	H	1
Iron	Fe	56
Magnesium	Mg	24
Nitrogen	N	14
Oxygen	O	16
Phosphorus	P	31
Potassium	K	39
Silicon	Si	28
Sodium	Na	23
Sulphur	S	32

Each symbol, however, is more than a mere shorthand method of writing the name of the element, and expresses besides a definite amount of the element which it denotes. For example, acetic acid is represented by the formula $C_2H_4O_2$; this indicates, in the first place, that it is a compound of carbon, hydrogen, and oxygen, and in the second, that it contains the carbon, hydrogen, and oxygen in the following proportions by weight (see above table):—

$$\begin{aligned} C_2 &= 12 \times 2 = 24 \\ H_4 &= 1 \times 4 = 4 \\ O_2 &= 16 \times 2 = \underline{32} \\ & \qquad\qquad 60 \end{aligned}$$

That is, 60 parts by weight of acetic acid contains 24 parts of carbon, 4 of hydrogen, and 32 of oxygen. In a similar way the composition by weight of any compound can be derived from the formula by the use of the atomic weights given above.

Classification.—In earlier times, when the number of chemical compounds known was small, each substance had a specific name which generally referred to its physical properties; thus, thick liquids were generally termed 'oils', *e.g.* 'oil of turpentine', 'oil of vitriol', and 'oil of cloves'—bodies of the most diverse chemical character. Similarly, volatile substances were generally known as 'spirits', *e.g.* 'spirits of wine', 'spirits of salts', and 'spirits of hartshorn'—bodies again possessing no chemical similarity whatever. As the number of known chemical compounds began to increase, however, this classification of bodies by their appearance had to be abandoned, and chemical compounds are now classified or grouped according to their chemical composition and properties; bodies found to consist of the same elements and to possess similar properties are placed in the same group, and these groups are further divided on similar lines. The number of organic substances known is now over 70,000, many new substances being discovered every year. It is obvious, therefore, that the systematic classification of such a large number of compounds is a matter of considerable difficulty and complexity. The principles underlying the classification may be most readily explained by the study of one or two of the more simple groups:—

Paraffins.	Alcohols.	Acids.
CH_4	CH_4O	CH_2O_2
C_2H_6	C_2H_6O	$C_2H_4O_2$
C_3H_8	C_3H_8O	$C_3H_6O_2$
C_4H_{10}	$C_4H_{10}O$	$C_4H_8O_2$
C_5H_{12}	$C_5H_{12}O$	$C_5H_{10}O_2$
⋮	⋮	⋮

If the members of any one of these three groups are considered it will be seen that each member differs from the member succeeding it by 1 atom of carbon and 2 atoms of hydrogen. Corresponding to this regular change in composition we find a gradual difference in their physical properties. The lower members of these series are generally gases or very volatile liquids, then follow a series of liquids of gradually increasing boiling-point, and finally we have bodies which are solids at ordinary temperatures. Thus the first member of the paraffin series, methane or marsh gas (CH_4), is a gas; pentane (C_5H_{12}) is a very volatile liquid, while the members above $C_{17}H_{36}$ are solids. Further, the members of any one series all exhibit great similarity in their behaviour to chemical reagents. The paraffins, for example, are very stable substances, resisting the action of strong oxidizing agents; the alcohols, on the other hand, are much more easily acted upon, and are readily oxidized; while the members of the third group differ from both the paraffins and the alcohols, which are neutral substances, in being typical acids.

Organic compounds are divided into two main groups—the aliphatic or fatty series, and the benzene or aromatic series; and the substances in each of these groups are classified in accordance with the principles indicated above. The first group owed its name to the fact that the animal and vegetable fats belong to it, and the second received its name on account of the pleasant aromatic odour of some of the earliest known members. Only a comparatively small number of organic substances are of direct interest or importance to the agriculturist, and these are dealt with in special articles throughout the Cyclopedia. [A. L.]

Organic Manures.—Dung, seaweed, composts composed of plant residues, refuse oil cakes and meals, wool, horn and all other manures composed of plant and animal substances, consist largely or entirely of organic matter. Organic matter consists of compounds of carbon with hydrogen, oxygen, nitrogen, and other ele-

ments, which compounds undergo decomposition with greater or less readiness. When placed in the soil, organic manures are oxidized and decomposed with production of carbon dioxide gas and the dark-coloured, complex organic matters which we call humus. The special value of organic manures lies in the fact that they produce humus, which has a most important effect on the condition and tilth of the soil. The chief organic manures, such as farmyard manure, seaweed, the nitrogenous organic manures, &c., are dealt with elsewhere under their appropriate headings. The percentages of nitrogen and ash constituents in organic manures vary very greatly. All plant and animal substances which are used as manure contain some nitrogen, and some of them, such as flesh, blood, wool, and other animal substances, are highly nitrogenous (see NITROGENOUS ORGANIC MANURES). On the other hand, few of the organic manures are rich in phosphates and potash. Generally speaking, they are either all-round manures, not very high in any of the chief manurial constituents—farmyard manure is an example—or they are specially nitrogenous manures like blood, flesh, and wool.

Organic manures are very popular with practical agriculturists. As these manures have to undergo decomposition in the soil before their constituents become available for use by plants, their action is prolonged and steady. Thus manures like shoddy, horn dust, and rape dust are preferred by most growers of hops, vines, roses, &c., to quick-acting mineral manures like sulphate of ammonia and nitrate of soda. It has been shown by experiment that if equal quantities of nitrogen are applied in the forms of, say, nitrate of soda and shoddy to two equal plots, the quick-acting and highly soluble nitrate of soda will almost certainly give a greater return in crop than the shoddy in the first year. But the effect of the nitrate of soda is all used up in one season, while the slowly decomposing shoddy continues to act for several seasons. Therefore if manures like shoddy are applied every season their residues accumulate in the soil, until eventually the soil becomes so rich in nitrogenous matter that the effect produced by the continuously decomposing residues of formerly applied manures is sufficient to make the effect of the slow-acting manure almost if not quite equal to that of an equal weight of nitrogen in a quick-acting manure applied every year. Further, the slow-acting manure has the advantage that its action is gradual and continuous throughout the whole season, while a quick-acting manure exerts its main effect rapidly and for a short period only, and therefore is apt to be forcing in its action. No doubt the mineral manures can be made to give as good or better returns both in quantity and quality of produce if wisely used, but it requires more skill to use them in proper quantity. Another advantage of organic manures is that they supply humus to the soil, by which the warmth, water-holding power, tilth, and other properties are largely affected and on which its fertility largely depends.

One disadvantage which applies to several of the organic manures is that they are generally very dear. Manures like rape dust, dried blood, flesh and fish guanos, &c., are limited in supply, but popular and in good demand. The price charged for them, therefore, is often far in excess of that for which equal quantities of all the substances of manurial value—including the humus—which they contain could be obtained in other first-class materials. [J. H.]

Organization, Agricultural.—The term 'agricultural organization or co-operation' is used freely in Great Britain and Ireland in reference to various proposals that have been carried out, especially of late years, for combination amongst farmers; but the name when applied to many of the undertakings called 'co-operative' is misapplied, and in consequence genuine co-operative efforts have been brought into disrepute. The form of organization proved to be best suited to the farmer's industry is the co-operative society, and this requires for its successful development the loyal co-operation of all its members. 'They enter into a relationship with each other wholly different to that which exists between the shareholders of a joint-stock company. Each member of a co-operative society has something to do, and the progress of these associations may be measured generally by the extent to which the members display that loyalty in co-operation, failing which the mutual benefits which the undertaking is intended to confer cannot be realized.' In a properly constituted agricultural co-operative society the amount of the capital is not fixed; the shares can be allotted at any time to any would-be member; the interest payable upon the capital is limited usually to 5 per cent, and the bulk of the profits is divided amongst the members as a bonus upon the amount of their sales through the society and their purchases therefrom. A limited liability company in which farmers take shares may be a form of combination, but it is not co-operation, and as a business effort is likely to be shortlived. A true co-operative society is very different from this. By the limitation of the interest on the share capital the society cannot become a mere concern for the investment of capital, because whatever profit is made over and above the 5 per cent is divided amongst the members in the shape of a bonus at the end of the year, in proportion to the trade they have done through the society. The fact that the share capital is not fixed, and that fresh shares may be allotted at any time on application, prevents the shares rising in value, and enables any farmer in the district to join the society at any time. Throughout the United Kingdom agricultural economists are preaching the gospel of co-operation as applied to the farming industry, and more and more men are proving the truth of these co-operative principles, first in Ireland under the leadership of Sir Horace Plunkett, then in England under the guidance of Mr. R. A. Yerburgh, and later in Scotland pioneered by Sir John Gilmour. In each country an agricultural organization society has been established. These bodies are purely propagandist, and are known respectively as the Irish, English, and Scottish Agricultural Organiza-

tion Societies. In 1894 the Irish society was formed. For five years previously Sir Horace Plunkett had gone up and down the country trying to convince the farmers of the need for organization. The progress in Ireland has been remarkable. The annual report of the Irish Agricultural Organization Society dated June 30th, 1909, shows the existence of 292 co-operative dairy societies, 57 auxiliary societies, 166 agricultural societies, 267 credit banks, 24 poultry societies, 35 home industries associations, 3 beekeeping societies, 12 flax societies, 4 federations, and 12 miscellaneous societies, including bacon curing. The aggregate membership of the societies is stated at about 100,000, and the turnover at about £2,000,000. The headquarters of the Irish Agricultural Organization Society are at Plunkett House, Merrion Square, Dublin. The English Agricultural Organization Society was founded in 1901. Forms of agricultural co-operation had existed in England previously, and farmers' clubs in many districts had undertaken the joint purchase of agricultural requirements. Co-operative purchase and sale were included in the programme of the National Agricultural Union founded by Lord Winchilsea in 1892; but it was not until the formation of the British Agricultural Organization Society by Mr. W. L. Charleton in 1900 that systematic efforts were made to promote agricultural co-operation in Great Britain. In 1901 an amalgamation was effected between the British Agricultural Organization Society and the National Agricultural Union through the efforts of Mr. R. A. Yerburgh, then M.P. for Chester, who accepted the presidency of the united bodies on the condition that political work was debarred, and the sole object of the society the promotion of agricultural organization. The new body was registered, and is known familiarly as the A.O.S. Mr. Yerburgh has been the president since its formation.

The number of societies affiliated to the Agricultural Organization Society at the end of 1909 was 331, consisting of 138 societies for the supply of requirements or sale of produce, 135 small holdings and allotments societies, 13 dairy societies, 29 agricultural credit societies, and 16 miscellaneous societies.

The total membership of the affiliated societies and their aggregate turnover in 1909 cannot be stated with accuracy as the returns are not yet available, but it may be estimated that the membership at the end of the year was about 16,500 as compared with 15,000 at the end of 1908, and that the total turnover was about £875,000 as compared with £770,000 in 1908. The offices of the society are at Dacre House, Dacre Street, Westminster, London, S.W.

The English Small Holdings Act, 1908, has produced an interesting development. It was apparent to the promoters of the bill that without co-operative effort the life of the small-holder would be difficult. One clause of the bill dealing with co-operation empowered the Board of Agriculture and Fisheries, subject to the approval of the Treasury, to make a grant to any society having as one of its objects the promotion of co-operation in connection with the cultivation of small holdings or allotments. An application for a grant was made by the Agricultural Organization Society, and the grant was given on the following conditions:—

1. That a grant of £1200 should be made if the income of the society from subscriptions and donations in each year were not less than £1200.

2. That if the income from subscriptions and donations exceeded £1200, the grant should be increased to an amount equal to such income, with a maximum of £1600.

3. That the grant in any year should be calculated upon the income of the society from subscriptions and donations in the previous year.

The committee of the Agricultural Organization Society has been reconstructed and consists of twenty-four members, six of whom are to be nominated by the Board of Agriculture and Fisheries.

The Scottish Agricultural Organization Society was founded in 1905. At the end of 1908 the number of Scottish societies was twenty-three. The annual report says these societies have been formed for the purchase of seeds, manures, implements, and other requisites, and for the sale of produce, especially of milk and eggs. The offices of the Scottish Agricultural Organization Society are at 5 St. Andrew Square, Edinburgh.

The growth of the agricultural co-operative movement in the three countries has been steady, and after serious deliberation in 1908 it was decided that some permanent machinery should be established whereby mutual consultation in matters relating to organization and united action in trade concerns could be resorted to, when the general work of the three countries could be furthered thereby. Two organizations were formed, a Joint Board for Agricultural Organization and a Joint Board for Agricultural Co-operative Trade, with Sir Horace Plunkett as chairman of each body. It is hoped that by the interchange of experience, and by the consideration of advice on the matters brought forward for deliberation, the work of the co-operative societies in the three countries will be strengthened, and the interests of the agricultural communities will be protected.

The National Poultry Organization Society has played an important part in organizing the poultry industry of Great Britain. The society was founded to carry out the following objects:—

(a) The organization and development of the poultry industry as a most important branch of British agriculture.

(b) The improvement of the quality and the increase of the quantity of eggs, poultry, &c., produced in the United Kingdom.

(c) The maintenance of regularity and uniformity of supply.

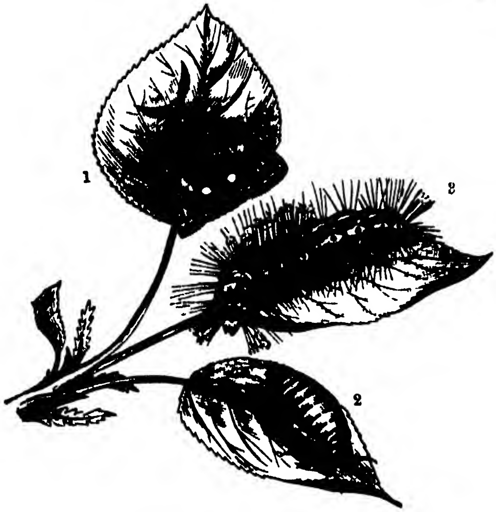
(d) The provision of facilities for rapid transit.

(e) To bring the producers and retailers into closer touch, in order that the best available market may be obtained at a minimum cost.

The organizing work of the society since April 1, 1908, has been taken over by the Agricultural Organization Society under the

arrangement made between the Board of Agriculture and that society, leaving the Poultry Organization to carry on the work dealing with the improvement of eggs and poultry and the marketing of same. The headquarters of this organization are at Regent House, Hanover Square, London, W. [J. N. H.]

Orgyia antiqua (the Vapourer Moth).—The Vapourer Moth is destructive alike to various fruit and forest trees. The caterpillars being most voracious, devour the foliage very raven-



Vapourer Moth (*Orgyia antiqua*)

1, Male; 2, female; 3, caterpillar.

ously. The male moth is found flying mostly in the autumn; in colour it is bright, rich, deep reddish-brown, with traces of a pale spot on each fore wing; the body is thin and the antennæ pectinated; the length is over ½ in. and the wing expanse over 1 in. The male flies in bright sunshine in an erratic but rapid manner. The female is devoid of wings; she is very fat and swollen, grey in colour. As soon as the female is hatched she crawls out of her cocoon and remains there. After being fertilized by the male she deposits her eggs in large masses side by side on the outer part of the cocoon and then dies.

The caterpillars which emerge from the eggs next spring vary in length from about 1¼ in. to nearly 2 in. when full grown; they are dark-grey spotted with small red tubercles, and have four large tufts of pale-yellowish or pale-brownish hairs on the back, two bunches of long hairs pointing forwards in front, one on each side of the fifth segment and another long one pointing backwards over the tail; the hairs in these five tufts are 'pinlike' in structure. They feed freely on the surface of the leaves soon after hatching until full-grown, which may be from June to September. They then spin an irregular cocoon of dull-grey silk mixed with hairs shed from their bodies and with some fine powder. These cocoons are spun amongst the leaves, against twigs and stems of trees, and on fences. Within the cocoons the larvæ change to dull-yellowish-brown pupæ slightly hairy, the female pupæ are larger than the male. The length of time in this stage is about two weeks, then the male escapes and flies about, and a little later the females crawl forth on to their cocoons.

This moth is common over England. Amongst fruit trees the plums are most attacked, then pears, and then apples. In the south of England the moth seldom is found before August.

Prevention and Remedies.—All cocoons should be destroyed in winter when any trace of the eggs is to be seen upon them. Much damage will be saved in this way. The larvæ that hatch out may easily be poisoned by spraying the trees with arsenate of lead. [F. V. T.]

Ornithology is that branch of natural science which deals with the origin, anatomy, geographical distribution, zoological position in the animal world, variations of plumage, and habits of birds. In this article some attention will be paid to birds in their economic relationship to the agricultural and horticultural industries.

The economic position of the House Sparrow in relation to agriculture and horticulture has inspired more controversy than nearly all other species of British birds combined, if we except the Rook. For the first time in the history of ornithology a Select Committee 'sat' on the House Sparrow in 1873. An enormous amount of evidence was taken. Here it is only necessary to say that the inference drawn from the opinions and facts submitted was that 'about 75 per cent of an adult sparrow's food during its life is corn of some kind; the remaining 25 per cent was roughly divided as follows:—

Seeds of weeds	10 per cent.
Green peas	4 „
Beetles	3 „
Caterpillars	2 „
Winged insects	1 „
'Other things'	5 „

Added to this damaging bill of fare must be debited against this bird its pugnacity in persistently driving away Swallows and House Martins, especially the latter, both of these birds being wholly insectivorous. We must bear in mind, however, that much of the grain found in the stomachs of the thousands of sparrows destroyed would be picked up from horse droppings in town and village streets and rural public highways, as much of that feedingstuff, especially oats, is discharged in an undigested form. Balancing the evidence pro and con, the impartial verdict must be that the House Sparrow does almost infinitely more harm than good.

All species of the family Corvidæ — ravens, carrion crows, hooded crows, rooks, jackdaws, choughs, jays, and magpies — are, in widely diverging degrees, more or less injurious. Ravens and choughs have become so scarce that they hardly count, although of late years, under the vigorous administration of the Wild Birds Protection Act, ravens have considerably increased in Galloway and Kirkcudbright, so that

there is a prospect of this species being withdrawn from the protective schedule. It is different with the other species, especially rooks, magpies, jackdaws, and crows, the latter two species being most destructive in every respect.

Rooks are on a different economic plane, and their habits have given rise to no end of controversy statistical, biological, and sentimental. During the last quarter of a century or more, rooks have changed their nesting habits to a marked degree, and so far on inexplicable grounds. This rook communal revolution has taken the form of the breaking up of great and ancient rookeries into widely scattered *petite* bodies, even to single nests in individual trees. Rooks, however, have not materially changed their feeding habits, certainly in no ways since Sir John Gilmour, Bart., of Montrave, carried out his enquiry into the subject (1894–95). His figures show 58 per cent of cereal consumption compared with 23 per cent of insects, grubs, &c., and on a superficial glance the case stands as a black indictment of the Rook. But, as in the far worse case of the House Sparrow, the large percentage of consumption of injurious insect grubs must count for a very great deal on the credit side of the Rook's account.

Such considerations tell to a considerable extent in favour of jackdaws, very little in favour of magpies, most destructive of the eggs and even fledglings of various kinds of insectivorous birds; whereas the carrion and hooded crows are almost wholly mischievous, and as for jays they are becoming so scarce that their economic position is hardly worth considering.

In his enquiry Sir John Gilmour embraced starlings and wood pigeons. The fluctuation of what may be termed the Starling population is a great mystery and cannot be assigned to increase or decrease of natural food, worms, and grubs of injurious insects. Going back for close on half a century and really embracing the country from John o' Groat's to Land's End, it is notorious that starlings as resident breeding species have almost completely deserted some localities, whereas they are now abundant in places where formerly they were unknown or excessively scarce. Why these birds should regularly breed only once a season in some areas, and regularly twice in others, and occasionally three times in a few districts, is equally puzzling. Here, however, abundance of specific kinds of natural foods or the absence of these may influence fecundity. The subject is worthy of practical investigation. In his analysis of Starling stomachs' contents these birds come out very favourably in Sir John Gilmour's report, and that has been more than confirmed by subsequent investigations.

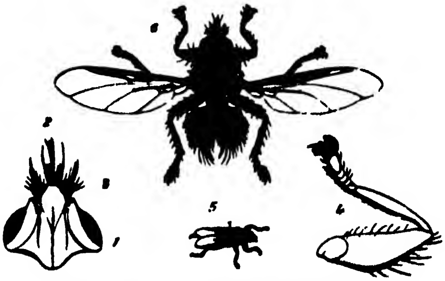
The Wood Pigeon (*Columba palumbus*), *alias* Cushat, Cushy-doo, or Quest, comes out very bad in Sir John Gilmour's report. As a matter of fact, it is the worst feather foe farmers have, and has only one really good quality—when properly cooked and served up under piecrust. It also affords good sport, and the man who can show a good bag of cushats must be not only a woodcraftsman but a particularly good shot.

As for the British Falconidæ—peregrine falcons, kestrels, merlins, sparrow-hawks, &c.—there is not one of the species that farmers should not rank among their friends, and even game preservers might find it to their advantage to spare the worst of them, the Sparrow-hawk (*Accipiter nisus*). In the years 1891–2 a plague of voles (*Arvicola agrestis*) worked enormous damage in several of the Scottish Border counties. The loss in two years was estimated at many thousands of pounds, and that visitation was only an unusual aggravation of a verminous infestation that had been going on for many years, *pari passu* with the persistent destruction of all kinds of hawks and owls not only by gamekeepers but by farmers.

The gradual re-establishment of the Lapwing, *alias* Peewit, in greater numbers in various parts of the country is a most gratifying fact, for there is no bird in existence so unqualifiedly the friend of the farmer as this.

All insectivorous birds should be rigidly protected, and if duly enforced the existing Act for that purpose is ample in every part of the country. See also art. BIRDS, and articles on specific birds, ROOK, &c. [G. W. M.]

Ornithomyia avicularia, Linn. (the Poultry Spider Fly), is one of the winged para-



Poultry Spider Fly (*Ornithomyia avicularia*)

sites which infests birds. It occurs upon fowls, the blackcock, pipit, and lark, &c. It runs sideways amongst the feathers, sucking the birds with its fine sharp proboscis. *O. avicularia* expands nearly ½ in., is flat, shining, dusky, green or tawny; the thorax has a reddish-brown dorsal stripe; the head is orbicular, whitish beneath (fig. 1); eyes large and black; mouth formed of two valves, with three fine horny tubes between them (fig. 2), and a short bristly horn on each side (fig. 3); abdomen orbicular, leathery, and hairy, the apex notched; wings ample, with pitchy costal nervures; legs stout and bristly, the feet armed with cleft claws (fig. 4, a fore leg, much magnified). It rests with its wings flat on the back (fig. 5); when flying it appears as in fig. 6 (magnified). It is generally found crawling about around the nostrils and ears, crawling into the openings and setting up violent irritation. The flies can easily be cleared from the cavities by sponging the openings with assafœtida (4 oz. to 1 qt. of water). [J. C.] [F. V. T.]

Orpington Fowl.—No race of poultry has within recent years attained the same degree of popularity as the Orpington, and more espe-

cially the Buff Orpington. It differs from many other breeds in that its varieties were separately formed, and the diverse elements bred to one general type. The first Orpington was the Black, produced by the late Mr. William Cook from Minorca, Plymouth Rock, and Langshan, the last named having half the total influence. It attained a large measure of favour, more especially among small poultry-keepers in the great centres of population, as it proved a quiet bird, a good layer, and suitable for the table. Next came the Buff, in which

Buff Orpingtons

both Dorking and Cochin blood are intermingled, the former giving to it white flesh and legs, and the latter the colour of plumage, and shape to some extent. This was one of the earliest races to combine production of tinted-shelled eggs with white flesh and legs—a combination which has made it especially acceptable at home and abroad. Both on the Continent and in the Colonies this variety is steadily winning a leading position, as much due to its meat qualities as to the fact that it is a fair layer. The third variety is the White, which is probably a sport from the Black or Buff. It lays large-sized tinted-shelled eggs, and in Denmark is finding favour on that account. It is white in legs, feet, and flesh. What is known as the Spangled is really a speckled Red Sussex. The Orpington is one of the larger breeds, males weighing when fully grown 9 to 10 lb., and females 7 to 8 lb. The body is broad and deep, and the breast carried well forward gives it an appearance of large size, which is enhanced by the shortish legs and by the large wings. The legs are stout but light-boned, and there are four toes on each foot. The head is small and neat, surmounted by medium-sized single comb. So far as coloration of plumage is concerned, Blacks are metallic and White pure bluish-white; the Buffs are very uncertain, and a mistake has been made in striving for buff tails. Black or very dark brown tails would be more natural, since it is generally found that the dark-tailed fowls are the most vigorous. The Orpington belongs to the General Purpose class, having a combination of qualities, namely, a fairly good layer, producing excellent flesh, and the hens reliable sitters and mothers. The chickens are hardy, but thrive better on light soils than on heavy land. [E. B.]

Orthesia insignis (the Lantana or Kew Bug).—In this country this scale insect is confined to greenhouses. It was first found at Kew in 1887 on a Strobilanthes in the Botanic Gardens, and has spread partly by constant fresh importations over the country. It feeds on a great variety of plants. Unlike most scale insects the 'Lantana Bug' is active, its six legs being long, as also are its antennæ. In colour the female insect is bottle-green or blackish, legs and antennæ fulvous, surrounded by a margin of flat waxy white plates, which after the first three on each side are directed backwards and downwards, at the end a long white tail-like process proceeds composed of waxy plates. The male is winged and has very long slender antennæ, greyish, very delicate wings, and a tuft of long silky white filaments at the end of the body, and very black eyes. The life-history has been followed abroad. There appear to be a succession of broods, insects in all stages being found at all times of the year. This takes place in hothouses in this country. The males appear only at irregular intervals, parthenogenetic reproduction being usual. It is doubtful if a generation of males occurs even once a year. The male has only been recorded from Ceylon, none has yet been found in this country. The females are very destructive.

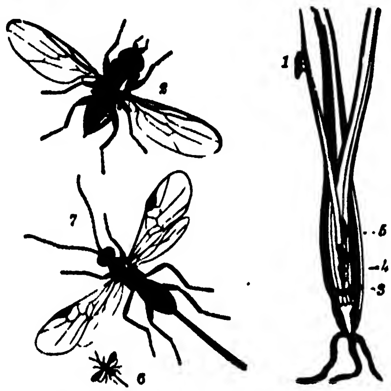
Treatment.—The most effective treatment is fumigation with hydrocyanic acid gas. Paraffin emulsion is good when on hardy plants, but delicate plants will not stand such a wash. [F. V. T.]

Orthoclase, a potash felspar which occurs as a mineral constituent of many rocks. See FELSPAR.

Oscinis frit (the Frit Fly). — This is a small black fly a little less than ⅛ in. long; it is rather shiny, the legs black, with dull-yellowish areas. It can easily be identified in the field by its skipping and jumping movements, being very active in habits. On the Continent both oats and barley are attacked, but so far it has not been observed in barley in this country except by Curtis. Instances of the corn being damaged have also come to the notice of the writer during the last few years. The main attack in this country is by the larvæ damaging the young oat plants. The disease is frequently spoken of as 'potley' or 'bottley oats'. The attacked plants present a very marked appearance. About the end of May the first signs commence, and continue throughout June. The leaves, especially the central ones, turn reddish-brown; the whole plant becomes stunted, brown, and shrivelled, and usually dies in the middle, but may tiller out and produce a certain amount,

but often dies right back. On examining the plants and gradually pulling the leaves off, we find small white and grey maggots hidden between them and the stalk, and also in the centre just above the level of the ground.

The fly is found from the third week in April to the beginning of May. She lays one or two, sometimes four, eggs on each young oat plant. As many as seventy eggs have been found in one fly. The maggot is cylindrical, and footless. It can be easily identified by two branched processes near the head, which are respiratory, whilst at the tail-end are two prominent wartlike structures used for the same purpose. The pupa is encased in the dried larval skin (*puparium*). This puparium is bright brown, cylindrical, and has two prominences at one end, the remnants of the two wartlike processes seen in the maggot. The flies hatch out from the puparia early in July. The summer brood lays



1, 2, *Oscinis frit* (nat. size and magnified); 3, base of blade eaten through; 4, larva in oat; 5, pupa (nat. size); 6, 7, *Sigalphus caudatus* (nat size and magnified), a fly that destroys the Oscinis larvæ.

its eggs in the ears, and the larvæ feed upon the developing cobs and thus check their growth, resulting in badly shrivelled samples. These maggots pupate amongst the corn, and the puparia come out when the grain is threshed. This second or summer brood hatch out in the latter part of August, and we find the small black flies then in swarms in granaries, outhouses, and barns. Many of these flies make their way to the fields and deposit their eggs on various wild grasses, and these hatch into flies, which hatch out and attack the oats in the following year. The flies live only a short time. There is at present no evidence to show that they winter in the puparium stage and may thus be distributed with seed. The attack undoubtedly comes from wild grasses. The Frit Fly prefers oats, for in dredge corn oats are attacked and not the barley.

Treatment.—The only thing that can be done is to get the seed in as early as possible, so that the plant has a fair start before the flies are about, and the use of some stimulating manure as a topdressing when we first notice the oats becoming 'potley'. Rough grasses at headlands and along hedgerows should be brrnt in winter. [F. V. T.]

Osiers, Cultivation of.—In the United Kingdom, willow rods or osiers are almost exclusively used in the manufacture of basketware of all kinds. For this purpose the value of the rods depends chiefly upon their length, toughness, and flexibility, and tc obtain these qualities it is necessary to grow the willows closely together, and to cut them back to the ground level at frequent intervals. The plantations thus treated are technically known as 'beds' or 'holts', and their cultivation on a large scale in the United Kingdom is principally confined to the banks of the larger rivers, and tracts of low-lying land difficult to drain for agricultural purposes.

The species of willows used for basketmaking are numerous, and vary in different districts. The most important are the following: *Salix viminalis*, the Common Osier (long skin, black tops, &c.); *S. triandra*, the French or Almond-leaved Willow (Norfolk, black mauls, &c.); *S. fragilis*, the Crack Willow (Spaniards, &c.); and *S. purpurea*, the Bitter or Purple Willow (dark dicks, &c.). This last-named willow thrives better on dry or sandy soil than most species. The names in parentheses are those by which they are frequently known in the trade. Of the above species, *S. viminalis* and *fragilis* produce strong rods, *S. triandra* medium, and *S. purpurea* light canes or osiers.

The soils and situations most suitable for osier cultivation are found on the alluvial banks of slow or sluggish rivers, which frequently overflow during the winter months, and deposit a rich layer of mud on the surface. In such situations the osiers make a vigorous growth, and the productive capacity of the beds is maintained for many years. Osiers can, however, be successfully grown on any soil of average depth and fertility, provided the rainfall is not too light; but unless artificially irrigated or manured, the beds become exhausted with continuous cutting. The preparation of the ground for osiers varies from ordinary ploughing and harrowing to deep trenching by hand. Where the soil is free from roots, stones, open drains, and inequalities of the surface, and summer flooding is unlikely to occur, the ground can be ploughed, and a crop of potatoes, roots, or cereals put in for the purpose of cleaning the surface for planting in the following spring. With a rough and uneven surface, or soil full of roots and stumps of woody plants, ploughing is seldom practicable, and spade labour is necessary. To obtain satisfactory results, the soil should be trenched to a depth of 1½ to 2 ft., and all surface growth completely buried.

In wet or swampy ground the first operation should be the draining of the surface by cutting open drains down to the lowest depth which will allow a fall in dry weather. These drains should run in parallel lines, and be about half a chain apart where the fall is sufficient to carry off the water as it collects. In very wet or swampy ground with little fall, it is often necessary to cut drains at intervals of 4 or 5 yds., and raise the general level of the surface between them with the soil taken out.

In planting the beds, cuttings from 9 to 12 in.

in length, and made from wood not less than ½ in. in diameter, are set out in straight lines parallel to the main drains. The stronger varieties (*S. viminalis*, *fragilis*, *triandra*, &c.) are usually planted at the rate of 10,000 to 12,000 per statute acre, or 2 to 3 ft. apart in the rows, and 2 ft. from plant to plant. The smaller varieties (*S. purpurea*, &c.) should be planted closer, or 2 ft. between the rows, and 1 to 1½ ft. from plant to plant. Closer planting results in a heavier yield for the first five years.

Planting is best done in February or March, provided the soil is fairly dry at the time. An ordinary garden line should be stretched along the surface, and the cuttings pushed into the ground at the proper intervals to within 2 in. of their full depth, taking care that the buds are pointing upwards. During the first summer after planting, the beds should be handhoed as often as necessary, as the ultimate success of the crop depends greatly upon the suppression of weeds and rubbish. In the case of the widely planted sets, hoeing can often be done with a light horse hoe after the first season, but until the plants are thoroughly established, hand work is preferable.

Cutting rods should be done between October and March. Each rod should be cut cleanly off with a strong pruning knife, leaving not more than ½ in. of the rod remaining on the stump or stool. Strict attention should be paid to this point, as badly-cut beds quickly degenerate, and diminish in yield and quality. After cutting, any blanks in the lines can be filled in by pushing into the ground a strong full-length rod, which, after the first season, can be cut to the level of the other stools, taking care that the rod thus inserted belongs to the same species as the bed. The preparation of the rods for market may consist in simply sorting and tying them in bundles in the green and unpeeled state, or may consist in 'peeling' or 'buffing'. In ordinary peeling, the rods are placed, butt downwards, in shallow ponds in April or May, which excites the cambium layer into activity, and allows the bark to be easily peeled off. 'Buffing' consists in steaming or boiling the rods with the same object in view, but when so treated the rods acquire a brown or buff colour which improves their appearance for many kinds of basketwork.

The cost of preparing the ground, cuttings, and planting, &c., amounts to from £20 to £30 per statute acre, and a bed properly formed and managed should continue in good bearing for about twenty years. An average yield may be put at 4 to 5 tons per acre, with a value of £5 per ton in the green state. Allowing £5 per acre for interest and cost of maintenance, the annual profits may work out at £10 to £20 per acre. To obtain these results, however, good markets for green rods must exist in the immediate neighbourhood, or exceptional transit facilities be provided. [A. C. F.]

Ostitis, or inflammation of the bone, is known in both the acute and in the chronic forms. Acute ostitis, which is of comparatively rare occurrence in the horse, is usually found in the bones of the limbs below the knee joint, and often involves a large area of the bone. Cases of ostitis affecting the upper and lower jawbones have been reported. This malady is usually the result of some external injury caused by some sharp instrument, *e.g.* a nail in the foot. Acute lameness, attended with great pain and a swelling of the surrounding parts, accompanies this disease. Abscesses form, and from these pus is discharged. The bone begins to decay, and blood-poisoning often follows. Even if the patient recovers he is seldom useful for after-work. The chronic form of ostitis is more common and less dangerous than the acute form. Here the affected bone becomes porous and spongy; this condition is succeeded by a process of ossification, so that the soft porous condition of the bone is changed into a state of great density and hardness. For treatment see BONE, DISEASES OF; NECROSIS.

Ostrich (Struthio), a genus of running birds with raftlike unkeeled breast bone. There are two or three species, distributed over Africa, and occurring also in Arabia and Syria. The Ostrich is the largest of living birds, standing 6 to 8 ft. high, and weighing up to 300 lb. The legs are very powerful, but extraordinarily brittle; there are only two toes—the third and fourth. The wings are not used in flight, but are outspread in running, and may increase the bird's swiftness. Their natural home is in the desert, and they often accompany zebras and antelopes. The Ostrich is polygamous, a cock being often accompanied by three or four hens. These females lay their eggs in a common hole in the sand, usually fifteen to thirty eggs, but there may be many more scattered about in the nest. The male sits closely all night; the females take turns during the day, but often leave the eggs just covered over with sand. The male also takes part in the care of the young birds. There are two African species—a southern one, *Struthio australis*, confined to the south of the Zambesi and Cunene rivers; a northern one, *S. massarcus*, with a reddish neck, occurring in German East Africa. The South American Ostrich (Rhea), with three toes, is easily acclimatized, but the feathers are of little commercial value. See next article. [J. A. T.]

Ostrich Farming is carried on in various parts of the world: South Africa, North Africa, Arizona, California, New Zealand, Australia, and southern Europe. But of all these, Cape Colony is by far the most important, as it is also the place of its origin. There the number of birds, including chicks, reaches over a million, and in 1907 the export value of the feathers amounted to £1,879,606.

The ostrich is farmed solely for the feathers which it produces, there being no other use to which any part of the bird is applied. Where properly conducted the industry is very remunerative; but it requires much experience and intelligence. From their gracefulness and delicacy when curled, ostrich plumes are peculiarly suitable for personal decoration, and in one form or another seem to be ever in fashion's demand, so that the future of the industry seems well assured. It is estimated that at least £5,000,000 per annum are paid to the re-

A SOUTH AFRICAN OSTRICH FARM

tailers of ostrich feathers, when the latter have been finished and manufactured ready for wear.

In the early days ostrich plumes were obtained by hunting and killing the wild bird, and there are still parts of Africa where this is carried on to a small degree. It is only within the last fifty years that the farming industry has arisen, the ostrich readily lending itself to domestication. At first the birds were allowed to roam almost wild in large wire-fenced camps, feeding on the natural herbage and bushes, and only collected at intervals for plucking and quilling. But with the development of the industry, and the greatly enhanced price given for superior feathers as compared with the inferior kinds, intense specialization has taken place. Now the birds are kept under more immediate control by enclosing in smaller camps and feeding largely on artificial food, particularly lucerne and rape, supplemented by grain and bone. By selective breeding great advances have also been made in the quality of feathers; pairs of breeding birds producing chicks of superior character are occasionally sold for as much as £1000 per pair.

Only certain of the feathers are taken for commercial purposes, those of the cock bird being more valuable than those of the hen. These include (1) the single row of wing quills, about thirty-five plumes to each wing, white in the cock and partly grey in the hen; (2) the two rows of wing coverts above these, black in the cock and drab in the hen; (3) the tail quills, from sixty to one hundred, brown and white in the cock, and grey and white in the hen. The single row of under coverts (floss) and the short feathers along the edges of the upper arm are sometimes taken. The plumes are usually clipped by means of shears as soon as completely unfolded, at which time they are at their best condition; while the quills are allowed to remain in the sockets and ripen, which they do in about two months after the plumes have been clipped. The quills are considered to be ripe when the blood has completely receded from the central pith, and they are then drawn by the aid of pincers. The process of artificial quilling is adopted, since the natural moulting does not proceed regularly for all the feathers, nor take place so frequently as when artificially controlled. It is found that the drawing of the quill at once stimulates the feather germ below to renewed activity; and as all the quills are extracted at one operation a complete new crop of feathers is secured, regularity or evenness of growth of all the commercial feathers being an important factor in ostrich management. The operations of clipping and quilling are quite harmless to the bird, signifying little more than the cutting of one's hair or the trimming of the nails; all these are epidermal growths, and therefore devoid of nerves and bloodvessels.

The number of crops of feathers obtained from each bird varies somewhat, dependent largely upon climatic conditions and the supply of food. In the higher central parts of Cape Colony, where the winters are severe, only one crop is secured each year, while nearer the coast a crop is taken every eight or nine months. The first clipping of feathers, which are known as spadonas, is taken when the chicks are about six months old, and the quills are drawn two months later, irrespective of the season, otherwise irregularities would be introduced. The second crop of plumes requires about six months for its growth, and the quills two months longer in which to ripen, and under favourable circumstances this regularity continues, producing an eight- or nine-month system. The feathers of the first few clippings differ in size, quality, and value. The chick feathers are the smallest and of least value, the first-after-chicks or juveniles are much larger, while at the third and fourth clippings the plumage assumes its adult and best condition. Under favourable conditions and good management, birds will continue to give good clippings for at least thirty or forty years.

After clipping, the feathers of each bird are sorted and tied in bundles according to the following trade classification: *whites* (wing quills of cock), *feminas* (wing quills of hen), *fancies* or *byocks* (particoloured wing quills of cock), *blacks*, *drabs*, *floss*, *tails* or *boos*, *spadonas*, and *chick*; these are again classed into various grades dependent upon their quality and other characters. Untouched in any way, the feathers are usually sold by weight, at the various auction centres, at a certain price per pound. Afterwards they are shipped to the European and American markets, London being the chief, where they are again sold at quarterly sales, ultimately reaching the manufacturers and retailers.

Ostrich plumes vary enormously in value, the present tendency being greatly in favour of high-grade feathers; many of these average the farmer from 10*s*. to 20*s*. each feather. While an inferior bird will yield scarcely £1 per plucking, a superior bird will bring in from £10 to £20, or even more. The commercial value of a plume is determined by reference to the following characters or 'points': length, breadth, density or compactness of flue, strength or self-support of flue, hard or woolly flue, quality and lustre, shape, thickness of the shaft, and freedom from barring and other defects. These can be determined at a glance by an expert.

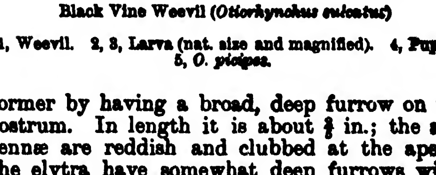
All ostrich farmers are also ostrich breeders, and great care is exercised in the selection of the best birds for breeding purposes. Under highly nourished conditions ostriches begin to breed when two or three years old, and are known to continue for over thirty years. Breeding pairs have to be isolated in special camps, as the cocks are extremely vicious and dangerous during the period, both to one another and to man. The nest, made by both cock and hen, is a shallow excavation in the ground. The hen lays an egg on alternate days, the number reaching from twelve to sixteen before incubation commences. The period of incubation is six weeks, the cock sitting by night and the hen taking her turn by day. Three or four nests may be secured in a single breeding season. Artificial incubation, either as a whole or in part, is also largely practised, by which means a greater number of eggs are obtained per bird. Often a breeding cock is given two hens instead

of one, and thereby double the number of eggs obtained. The chicks from the incubator are reared by hand or by foster-parents, and are able to peck from the beginning. The rearing of chicks, whether hatched naturally or artificially, calls for great care and experience, otherwise the mortality is frequently great.

Ostriches are much subject to several kinds of parasites, especially during their first two years; but once the pitfalls of youth are passed they are peculiarly free from disease, though liable to accidents in connection with the wire fences. In young birds regular treatment has to be carried on against tapeworm; a wireworm, *Strongylus douglasii*, living in the glandular part of the stomach, leads to great loss; mites and flies often infest the feathers and prove troublesome to both young and old birds. [J. E. D.]

Otiorhynchus picipes, Fab. (the Raspberry or Clay-coloured Weevil).—This weevil lies concealed by day, coming forth after sunset to feed, until sunrise, upon the leaves and stems of peas, beans, turnips, the cabbage tribe, wall fruit, vines in hothouses, and also hops. The main damage recorded is, however, to raspberries. They also attack cherry trees and gnaw the rind and buds of grafts. The fleshy larvæ live in the earth, feeding upon the roots of flowers, strawberries, and bush fruit, through the autumn and winter; in the spring they change to pupæ, and, shortly after, the beetles hatch. They are about $\frac{1}{3}$ in. long, mottled with minute scales of a clay and grey colour; the head forms a short stout beak, with two elbowed antennæ; the thorax is oval, and warty; it has no wings, but the wing cases are oval and convex, with eighteen or twenty slightly raised lines, and as many rows of pale dots between them; the legs are strong, and terminated by sharp claws. For methods of prevention and treatment see O. TENEBRICOSUS. [F. V. T.]

Otiorhynchus sulcatus (the Black or Vine Weevil) is easily distinguished from the



Black Vine Weevil (*Otiorhynchus sulcatus*)

1, Weevil. 2, 3, Larva (nat. size and magnified). 4, Pupa. 5, *O. picipes*.

former by having a broad, deep furrow on its rostrum. In length it is about $\frac{3}{8}$ in.; the antennæ are reddish and clubbed at the apex; the elytra have somewhat deep furrows with a few yellowish hairs. There are no wings. They feed upon the leaves of fruit and ornamental trees out-of-doors and under glass on ferns, orchids, &c. The larvæ also attack the roots. The weevils are nocturnal in habit. They fall to the ground on the least shock and feign death, remaining in that manner quite a time. The eggs are laid in summer in the ground. The grubs are to be found from early autumn until March amongst the roots of plants; they are creamy-white, legless, curved and wrinkled, with pale-brownish hairs scattered about. The pupa is yellowish-white and covered with reddish hairs. It is to be found in early spring at a depth of from 2 to 4 in. under the surface; this stage lasts about two weeks. Vines under glass and hops are also attacked by this beetle, the shoots being gnawed and thus destroyed. [F. V. T.]

Otiorhynchus tenebricosus (the Red-legged or Plum Weevil), a larger and darker weevil than the former, often most destructive to plums, raspberries, cherries, apricots, nectarines, strawberries, and peaches. It is especially harmful in the London district and in the south and south-east of England, notably on chalky land. The beetle is black and shiny, about $\frac{1}{3}$ in. long, but smaller specimens often occur; the wing cases have lines of small punctures and scanty ashy-grey scales; the antennæ are slender and elbowed; the legs are dull-red. The beetles strip the shoots of their leaves, destroy the buds, eat the tender bark. They are nocturnal, shelter under leaves, and if near walls in crevices between the mortar, also in the soil at the foot of the wall, and behind the stems of wall trees. The eggs are laid just under the soil; they are at first white, but in two days they become black. In August and September they hatch into small white footless maggots very similar to the former. The main food of the larvæ seems to be the roots of the strawberry and bush fruit, where they may be found until the following March or April. The pupa is found in an earthen cell; it is brownish-white, usually situated about $2\frac{1}{2}$ in. beneath the surface; this stage lasts from fourteen to twenty-one days. There are probably two broods or annual generations.

Preventive and Remedial Measures.—The adults may best be destroyed by jarring them off the plants on to tarred boards or sacks. This must be done, however, at dusk or night,—a moonlight night if possible, or lanterns must be used; if so, care must be taken not to flash the lights on to the bushes to be jarred, as the sudden light causes the weevils to fall; the jarring must also be done cautiously until the boards are on each side of the plants. Constant moving of the soil is beneficial with horse or hand hoes, and lime and soot may be prong-hoed into the land. The same method of jarring may be adopted in vine houses. As the majority of the weevils leave the trees by day, sticky-banding the trees where attack is bad would be worth while, as the beetles, having no wings, must ascend via the trunk. The beetles may easily be trapped by placing pieces of sacking at the base of the trees; they collect there and can be destroyed during the day. When the beetles are damaging wall fruit it would be well to have all the crevices in the mortar filled up, and the soil along the foot of the wall cleared out, and a line of tar run thickly along it.

The larvæ in the soil are more difficult to deal with, but some benefit has resulted from the use

of agricultural salt and strong ammoniacal liquid. Vaporite kills these larvæ in the soil. Ferns and other pot plants are best treated by fumigation with bisulphide of carbon, after the plant has been removed from the pot. [F. V. T.]

Otter (*Lutra vulgaris*), an aquatic carnivore in the family Mustelidæ, characterized by webbed feet with small blunt claws and naked soles, broad flat head, and the tail more than half the length of the body. The length of head and body is 25 to 29 in.; of the tail 15 to 16 in.; the general colour is deep-brown above with a slight tendency to be ruddy, and light-brown to whitish below. There are thirty-six teeth; the canines massive and somewhat recurved. The Otter is a very wideawake animal, keen in scent and hearing, quick to learn, very intelligent. It feeds chiefly on fishes, but does not despise crabs, frogs, small birds, or almost anything aquatic. The Otter is widely distributed throughout Europe and in many parts of Asia; in Britain it is commoner than is usually supposed. It especially frequents quiet rivers of considerable size where there are abundant trout. In the north of Scotland it often lives on rocky coasts, and swims far out to sea. It runs swiftly on land, and it outswims many a fish in the water. When it catches a fish it brings it ashore and eats it there, usually leaving the head and the tail. They habitually kill more than they can eat. The Otter's lair or 'holt' is in a burrow in the river's bank, or in a hole at the root of a tree, or in a cave by the shore. Except at the breeding season the Otter lives a solitary life. The female gives birth in March or April to three to five young ones after a gestation of nine weeks. The cubs remain for a long time with their mother. They may be easily tamed, and can be trained to catch fish.

Otter-hunting is a favourite sport, but the opportunities are not usually many in Britain. On the Continent the trade in otter skins is important. The importance of the Otter in Britain is that it may kill many salmon and trout in a good stream, and that it occasionally attacks lambs. Its flesh is edible. The Sea Otter (*Enhydris*) from the shores of the North Pacific is more thoroughly aquatic than the Common Otter. It is now very scarce, and a good skin is worth £200. [J. A. T.]

Otter Hound.—The general appearance of the Otter Hound is that of a most picturesque-looking, rough-coated hound, with a massive, slightly domed skull and a most powerful muzzle. The ears are of fair size and hang flat against the sides of the head; the neck is of a good length, strong and muscular, whilst the shoulders slope and are laid well back, the Otter Hound being a very much more active animal than his appearance suggests. The body is well let down behind the forearms; the ribs nicely sprung; the back is very strong and muscular, and the loins deep. The fore legs must be of fair length, perfectly straight, set on under the dog, and possessed of plenty of bone; whilst the feet are large, thick-soled, and possessed of web toes so that the hound can swim better, as he does much of his hunting in the water. The hind quarters are very powerful and carry a great deal of muscle, the thighs and second thighs being more developed than is the case in many breeds, whilst the tail is carried rather up, as is the case in all hounds. The prevailing colour is grizzle, which in connection with the shaggy coat produces a very picturesque effect. The coat itself, as is usual in all the rough-coated varieties of dogs, consists of two parts—the under and the outer—of which the former is very close and much resembles sealskin, whilst the outer one is harsh, profuse, and close, the combination of the two producing a jacket which is practically impervious to wet, and which keeps its possessor warm and dry excepting under the influence of exceptional exposure to rain and damp. [V. S.]

Otter Hound

Ovum, or **Egg-cell.**—Apart from cases of asexual reproduction and parthenogenesis, every multicellular animal begins life as an ovum or egg-cell with which a spermatozoon or male cell has entered into intimate union. The ovum has the usual characters of a cell; it is a unit of living matter with a complex microscopic structure: it has a nucleus (the so-called germinal vesicle) with a definite number of readily stainable (chromatin) bodies, it often has a store of reserve material (the yolk), and it usually has something in the way of a wall or envelope. The young ovum in the ovary is often amœboid; it grows at the expense of adjacent cells, or by absorbing material contributed by special yolk glands or supplied from the vascular fluid of the body. In the majority of cases ova are

minute; those of most mammals are not so large as pins' heads; those of many worms and the like are microscopic. As in birds they may be increased enormously by an accumulation of yolk. Round the egg there are often sheaths or envelopes of various kinds—(*a*) made by the ovum itself, and then very delicate (*e.g.* the vitelline membrane); (*b*) made by adjacent cells (*e.g.* the follicular envelope); (*c*) produced by special glands or glandular cells in the walls of the oviducts (*e.g.* the 'shells' of many eggs). Inside the egg, whether large or small, there lies, in a manner inconceivable to us, the potentiality of an organism—the whole maternal inheritance. This awaits the liberating stimulus of the spermatozoon (which also brings in the paternal inheritance). When fertilization has taken place the development begins. [J. A. T.]

Owls (Striges). — These highly rapacious birds were formerly associated with the diurnal birds of prey, but are now considered to constitute an order of their own. When perching, *two* toes are usually turned backwards, instead of one only as in hawks and perching birds. The large eyes are correlated with active life at dusk and dark, and the flight is unusually noiseless. As the food consists mostly of mice, voles, and other pests, together with birds and reptiles, owls are among the best friends of the farmer. At times they destroy bats and useful small birds, but this mischief is far outweighed by benefits conferred. Three species of owls are British residents, and two regular visitors. These are the following:—(1) Barn or Screech Owl (*Strix flammea*), our smallest resident (13 in. long), distinguished by its pale tints. The two to six eggs are laid in pairs in an apology for a nest, constructed in a barn or tower. They are white and round. Eleven stomachs examined by Newstead contained between them—12 voles, 1 house mouse, 1 long-tailed field mouse, 5 shrews, 2 bats, 3 small birds, 4 beetles, and a moth. (2) Long-eared Owl (*Asio otus*).—This common resident species is larger (15 in. long) than the preceding, and darker in colour. It is distinguished by the long dark-centred ear-tufts. The eggs resemble those of the Barn Owl, and are deposited in deserted squirrel-dreys, or nests of blackbird, &c. Food much as before. (3) The Tawny or Hooting Owl (*Syrnium aluco*), the largest (16 in. long) of our native species, is well known in most of Great Britain, but absent from Ireland. The toes are feathered down to the talons, the white-tipped tail barred with brown, and the wings spotted with white. The four white round eggs are usually deposited in a hollow tree. Food much as in the Barn Owl, but Newstead also records earthworms and grey slugs. He examined 75 pellets, which contained the remains of 29 voles, 16 mice, 69 shrews, 37 birds, and a few dung-beetles. (4) Short-eared or Woodcock Owl (*Asio accipitrinus*).—This species is rather smaller ($14\frac{1}{2}$ in. long) than its long-eared cousin, and the ear-tufts are much shorter. It is mostly a winter visitor, but a few breed in the Fens and in Scotland. The four to six cream-white eggs are laid on sedge or heather. This owl is less nocturnal than the preceding species. Food as before. (5) The Snowy Owl (*Nyctea scandiaca*) is a winter visitor to North Scotland, and its white plumage is spotted with black. This species is said to be destructive to game, and also feeds on fish. [J. R. A. D.]

Ox.—In a purely zoological sense the term ox may be taken as synonymous with the term Bos, as name of a genus, or even with the family name Bovidæ, into which all species of wild and domesticated cattle are grouped. The term is also applied commonly to cattle used for draught purposes. It is also used as the synonym of bullock, meaning the castrated male of any domesticated breed. [J. B.]

Ox-eye is a genus of Compositæ plants with watery juice, distinguished from the Daisy by the larger flower-heads, and by the leafy stem—the Daisy has a leafless scape.

White Ox-eye, or Ox-eye Daisy (*Chrysanthemum Leucanthemum*), is a perennial herb with an underground stock, from which the flowering shoots arise and reach the height of 1 or 2 ft. Flowering occurs from June to August. As in the Daisy the flowers in the head are of two colours, the outer white and the central yellow. This is a common weed in dry pastures; to extirpate, the stocks should be pulled out, or the shoots should be cut young.

Yellow Ox-eye, or Corn Marigold (*Chrysanthemum segetum*), is an erect annual weed of cornfields, about 1 ft. high. Unlike the Daisy, the outer flowers of the head are yellow. Flowering occurs from June to August. To extirpate, apply lime dressings and prevent seeding. See CHRYSANTHEMUM. [A. N. M'A.]

Oxford Down Sheep.—Though of comparatively recent origin, the Oxford Down has won for itself a leading position among the sheep breeds of Britain. The exact date of the foundation of the breed is uncertain, but the fact remains that it has been established and consolidated within quite modern times—indeed almost within the early days of some of its present breeders, among whom the name of Mr. John Treadwell stands out prominent. There seems to be a general consensus of opinion that the present-day Oxford Down sheep is the result of the admixture of the various strains of blood represented by those breeds now known under the names of the Cotswold, the Hampshire Down, and the Southdown.

There is still in existence a flock of Oxford Downs whose origin dates back to the earliest history of the breed. This flock is at present owned by Mr. J. Bryan, Southleigh, Oxon, and it is quite certain that the original owner of this flock, Mr. William Gillett, and Mr. S. Druce of Eynsham, were among the earliest breeders, if not indeed the first breeders of the Oxford Down sheep. These two men purchased from the late Mr. Jonas Webb Southdown ram lambs, which they crossed with Cotswold ewes. Mr. Druce also bought some Southdown ewes, and then crossed them with the Cotswolds. Other breeders about this time were mating Cotswold ewes with Hampshire Down rams.

Amongst other names of those who were considered to be the leading Oxford Down breeders of the earlier days occur Messrs. Arkell, Pusey,

Photo Parsons

OXFORD DOWN RAM

FIRST AND CHAMPION OXFORD COUNTY SHOW 1909

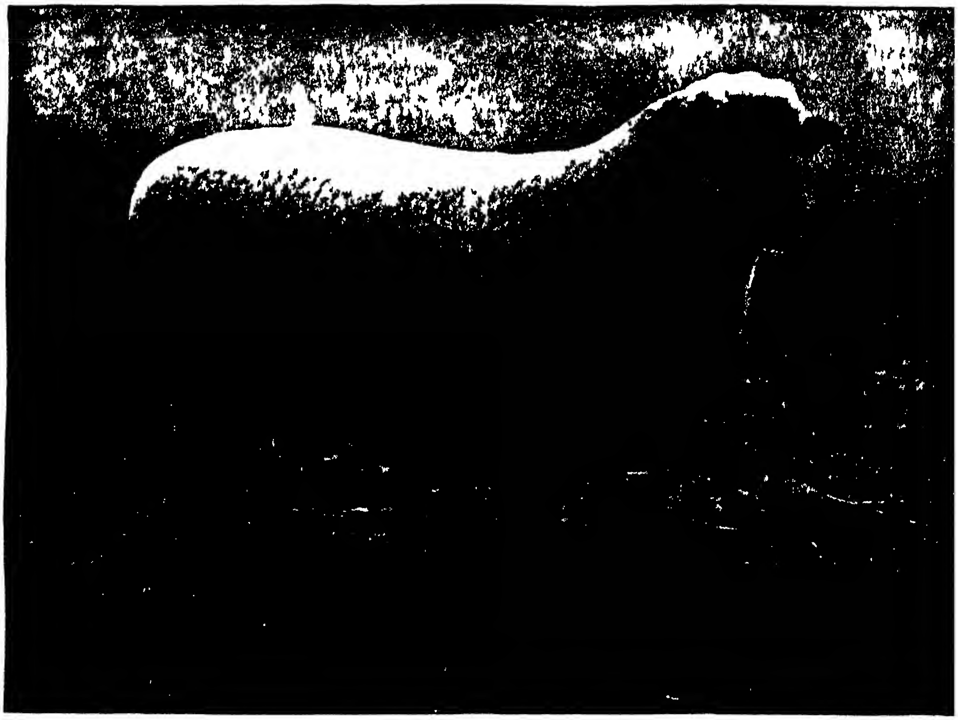


Photo C Reid

OXFORD DOWN EWE

[illegible] FIRST PRIZE PEN R A S E SHOW 1908

and Longman. Then, says that great authority on sheep breeding, Mr. J. Treadwell, 'came those well-known breeders, my own contemporaries, Messrs. Stilgo, Hobbs, Bryan, and Howard'.

The breed was first exhibited at the Royal Show at Battersea in 1862, and from that time up to the present it has been exhibited at the 'Royal' and all the other leading shows where prizes are offered for it. Originally started for the benefit of the breeders and feeders of mutton sheep, more particularly in Oxford and Gloucester, the breed has now secured a world-wide reputation, and year by year the demand for it has increased both at home and abroad. It has been pointed out that the present-day demand is for small joints and lean meat. Such a demand operates in favour of the Oxford Down, for there is no other breed of sheep that gives a deeper cut, or a bigger proportion of lean to fat. The weight of the carcass can be varied from 7 st. or 12 st. at the discretion of the feeder, for the Oxford Down lamb can be made fat at any given age and weight, and so can the wethers.

A typical description of that breed, taken from the official record of the Oxford Down Sheep Society, is as follows: 'He has a bold masculine head, well set on a strong neck; the poll is well covered with wool and adorned by a top-knot; the ears are self-coloured, and of good length; the face is a uniform dark-brown colour, the legs are short, dark-coloured (not spotted), and well placed outside him; the barrel is deep, thick, and long, with straight underline, the chest wide; the back level; ribs well sprung; tail broad, and well set on; the mutton is firm, lean, and of excellent quality; the fleece is heavy and thick on the skin'.

One of the most striking features in connection with this breed is the proved value of the pure-bred Oxford Down sheep for the production of cross-bred sheep.

The best market for the Oxford Down sheep at the present time is found in Scotland, where the Oxford Down is highly popular, and popular for the purpose of breeding cross-bred sheep.

The best, the fullest, and the most representative exhibition of the breed is to be found at the Oxford County Show. There are classes for the breed at the Bath and West of England Show, at the Gloucester County Show, at the Northampton County Show, at the Royal Counties Show, and of course at the Royal Agricultural Show.

It is somewhat remarkable that a breed which almost within the memory of living men was a cross breed itself, should prove so prepotent. The cross resulting from the union of an Oxford Down ram and a ewe of any other breed invariably bears the merits and the good qualities of the former. Hence it is that the Oxford Down is now one of the most popular sires for crossbreeding, and no stronger evidence can be adduced to show the superiority of the Oxford Down as a breed for producing mutton of the right quality and quantity. The results of many experiments have shown that the Oxford Down sire, when mated with the Leicester, the Border Leicester, and other north-country ewes, is the most profitable sire for the production of lambs that can be sold and finished under the year. In our present day it is the quick return that pays, and any breed that can produce a cross-bred lamb that will mature and provide the necessary depth of flesh and quality of meat in the quickest time is the breed that pays the best. Such a breed is the Oxford Down of the present day.

The Oxford Down Sheep-breeders' Association was amongst the earliest associations started in this country. It was founded in the year 1889, with an entry of seventy-five flocks, and its record is now closed to all except pure-bred sheep. The North American Flock Book was founded even earlier than the home flock book; in the United States the Oxford Down has secured a leading position amongst the breeds of mutton sheep. Breeders from the United States come here year by year to select from the leading flocks typical specimens of the breed.

Good specimens of the breed can be purchased from almost any breeder who owns an Oxford Down flock. The foremost public sale is that of Mr. J. Treadwell at Winchendon, near Aylesbury, Bucks, where some sixty or more of the choicest rams of that well-known flock are annually offered for unreserved sale. At the Cirencester August Fair, Mr. J. T. Hobbs of Maiseyhampton offers his annual selection of yearling rams; and at the same fixture a very large number of the other breeders make entries of both yearling rams and ram lambs. Then there is the great annual fair held at Oxford, where, as regards both rams and ram lambs, one finds the most representative entry of the breed.

At Kelso, in Scotland, owing to the large demand for the breed at the present time in that district, and other north-country fairs, and also throughout the counties immediately contiguous to Oxfordshire, a considerable number of rams and ram lambs are always on offer throughout the season. [W. W. C.]

Ox Louse. This pest is described in the art. HÆMATOPINUS.

Ox Warble Fly, the insect which causes the familiar warbles on cattle. See HYPODERMA.

Oxyuris, a genus of threadworms, one species of which—*Oxyuris vermicularis*—is one of the commonest and most widespread parasites of the human intestine, while others occur in horses, rabbits, and many other Vertebrates and Invertebrates. The common species in the cæcum of horses is *O. curvula* (190 have been found in one horse), that in rabbits and hares is *O. ambigua*. The Oxyures are rather small threadworms, thus the female of *O. vermicularis* is about 10 mm. long, and the male decidedly less. They seem to pass in with vegetable food, but in the case of *O. vermicularis* the embryos may re-enter the host of their parents. Oxyures give rise to irritation and itching, but not usually to serious results. [J. A. T.]

P

Paddock. — Any small grass-covered and fenced piece of land. Such accommodation usually exists close to the homestead, where it is convenient to keep an invalid or restrain an injured animal from galloping about. A small paddock that is level is favourable for lame horses under treatment. [H. L.]

Pæony, or **Peony.**—Pæonia, a genus of large-flowered hardy Ranunculaceæ widely distributed in Europe, Asia, and North-west America. Some of the species have fleshy perennial roots and herbaceous annual stems. Others, known as Tree Pæonies, have woody stems, and grow sometimes 6 ft. in height, forming quite presentable shrubs. The garden representatives of Tree Pæonies are chiefly of Japanese origin. Many named varieties have been introduced into Europe, and are now established garden favourites. They do not, however, thrive in all gardens. They appear to prefer a deep moist soil, a sheltered position with shade from morning sun, and protection from cold winds in spring, as they bloom early on the young growths which start in April. Some cultivators for this reason prefer to grow them as pot plants, placing them under glass as soon as they begin to grow, and after the flowers are over plunging them out-of-doors along with chrysanthemums, &c. They are often grafted on roots of the herbaceous Pæony, and the stock is therefore apt to outgrow the scion unless the root suckers are removed. The size of the flowers, their richness and variety of colours, and in most cases beauty of form, render Tree Pæonies of great decorative value in the garden. A yellow-flowered species, known as *P. lutea*, has recently been introduced from China, and hybrids between it and *P. Moutan* have been raised in France.

Herbaceous Pæonies, of which about two dozen species are known, all hardy spring-flowering border plants, are among the easiest of plants to cultivate, and may be recommended for gardens in smoky towns, and where the soil is not of the best. In parks and large gardens they should be planted in large bold masses, either by themselves or in front of shrubberies. Pæonies are somewhat impatient of disturbance at the root, but when once established they will live and thrive for many years without further trouble beyond a summer mulch with well-rotted stable manure. It is difficult to kill Pæonies. They withstand any amount of cold or heat, and no vermin, insects, or slugs attack them; but they are subject to a fungoid disease which attacks the young stems at the base, causing the whole stem to suddenly droop, and in a few days to die. The fungus *Botrytis Pæonia* spreads with alarming rapidity when once it has established itself in a Pæony bed. As a preventive measure all drooping stems should be removed at once, and care exercised in the application of manure, which should be well rotted before being placed about the plants.

The species of Pæony from which the garden sorts have been bred are *albiflora*, *officinalis*, *peregrina*, and *tenuifolia*. There is an enormous number of named varieties in cultivation. [W. W.]

Palæozoic, a name for the rocks and the geological era in which the older faunas ('old life') appear upon the globe. The base of the group has been fixed by a particular fauna which existed at the opening of the Cambrian period; and hence any indications of life older than this horizon are pre-Palæozoic or Archæan. The Palæozoic era closes at the end of the Permian period. [G. A. J. C.]

Palm is the comprehensive name applied to all the plants forming the nat. ord. Palmaceæ of endogenous plants indigenous to tropical and subtropical regions. Palms are arborescent trees and shrubs with spirally arranged leaves and often spiny leaf-stalks, and with numerous small and usually yellow, often strongly-scented flowers infloreseing in a simple or many-branching spadix enclosed in a spathe of one or several valves. In some kinds the male and female flowers are on different plants. The fruit may resemble a berry, drupe, plum, or nut. Some palms are stemless and have their foliage spreading directly above the ground; others have tall, slender, erect, simple, rarely-branching stems supporting a graceful crown of foliage, partly erect and partly drooping; while others again (the Rattan genus, Calamus) are cane-like and spread along the ground, or climb trees and support themselves thereon by means of strong hook-like prickly processes. Outwardly hard and often silicated and polished, Palms show internally the usual characteristic appearance as to the vascular bundles in endogenous trees. The stems of the erect kinds are usually deeply marked by the scars of dead leaves near their base, while higher up the stumps of the stalks of the dead and cast foliage often long persist as tough brown masses of more or less matted fibres, or as rough, pointed snags. In respect of the trunk surface, however, as with regard to foliage, two great classes may be distinguished, one with smooth and shining stem, showing the scars of leaf-stalks as raised rings at greater or less distance from each other (as in Cocos, Areca, Calamus); and the other having the stem covered with the persistent base of the leaf-scars, or their scars arranged round the stem in a series of close spirals (as in Borassus and most species of Phœnix). The leaves of palm trees vary greatly in size and appearance. They are either round and fan-shaped, and with veins radiating from the top of the leaf-stalk, in the 'flabelliform' group of which Corypha and Borassus are typical; or else elongated and pinnately veined, with veins issuing from the sides of a strong midrib which extends to near the point of a blade cleft down to the apex of the midrib, in the 'pinnate' group of which Phœnix, Areca, Cocos, and Calamus are all typical. The Palm order contains about 140 genera and 1000 species; but only one is indigenous to southern Europe, the Dwarf Palmetto

Palm (*Chamærops humilis*), a slow-growing, fan-foliaged dwarf species seldom reaching over 10 to 15 ft. high, but yielding edible fruit and good fibre for coarse weaving and papermaking. Palms yield many valuable economic products, including fruits, oil, and fibres. In the 'flabelliform' group the most important are: (1) The Palmyra or Toddy Palm (*Borassus flabelliformis*), a tropical African species now largely cultivated throughout India, Burma, and Siam, whose stems often form house-posts, whose leaves are used for writing upon, and whose sap yields sugar (jaggery) and a liquor (toddy); (2) the Talipat Palm (*Corypha umbraculifera*), indigenous to and largely cultivated in India, Ceylon, and Burma, with large leaves often 10 ft. in diameter used for thatching, fans, mats, umbrellas, and for writing on; and (3) the Australian Cabbage Palm (*Corypha australis*), giving fibres woven into clothing, netting, and hats. The 'pinnate' group contains by far the largest number of genera and species, the most important being: (1) the Date Palm (*Phœnix dactylifera*), indigenous to Northern Africa and Western Asia, but now very widely cultivated elsewhere for its nutritious fruit (finest kinds come from Persian Gulf); (2) the Cocoa or Coco Nut Palm (*Cocos nucifera*), indigenous to the Indian coast and the South Sea Islands, but now abundant near the sea-coast in most parts of the Tropics, yielding valuable copra, oil, and fibres from its nuts (ripening in nine to ten months); (3) the Sago Palms (*Sagus Rumphii*, *S. lævis*, and *S. farinifera*) and the Sugar Palm (*Arenga saccharifera*) of Indo-China and the Indian Archipelago, yielding sugar, spirits, and sago (from stem); (4) the Areca Palm (*Areca Catechu*) of India, yielding the betelnut; (5) the *Caryota urens* of India, yielding fibre, sago, sugar, and toddy; and (6) the Rattans (Calamus), of which there are about 170 species in south-eastern Asia, northern Australia, and tropical Africa, which mostly climb by means of whip-like thorny flagella, and sometimes attain 300 to 400 ft. in length. Palms can only be grown under glass in Britain; but many are grown in the open on the Riviera. [J. N.]

Palmnut Cake is made by pressing the kernels of the Palm nut (*Elæis guineensis*). The inner portion of the kernel is white, but the outer layer of brownish coloured woody fibre gives the meal obtained from the crushed kernels a speckled appearance. The kernel contains about 50 per cent of oil, and even after extraction of the oil in presses a considerable amount of oil may be left in the meal or cake. The crushed kernel is either made up in the form of cake, or else is kept as meal. The meal is sometimes further treated with chemical solvents and the oil nearly all extracted.

The cake and meal are not manufactured to any great extent in this country. Palmnut meal is, however, extensively used on the Continent, especially for dairy purposes. The meal imported from abroad is generally poorer in oil than that made in this country. The oil shows some tendency to turn rancid, and palmnut cakes will not keep sound for long. The use of palmnut is practically confined to cattle—especially milking cows—and it is not given to sheep or pigs. It is considered to produce a good quality of butter. The general composition of the cake and meal may be represented by the following analyses:—

	Palmnut Cake.	Palmnut Meal.
Moisture	9·73	9·99
Oil	9·14	12·91
[1] Albuminous compounds	15·89	16·18
Digestible carbohydrates, &c.	41·66	35·57
Woody fibre	19·74	21·80
Mineral matter (ash)	3·84	3·55
	100·00	100·00
[1] Containing nitrogen	2·54	2·59
Albuminoid ratio	1:4·1	1:4·2

The meal when extracted by chemical solvents may have as little as 1·5 per cent of oil.

Considered from a manurial point of view palmnut cake is inferior to cocoanut cake, as it contains nearly 1 per cent of nitrogen less than the latter. It has 1·20 per cent of phosphoric acid and ·50 per cent of potash. On Voelcker and Hall's Tables the compensation value for 1 ton of the cake consumed is as follows:—

Last year.	Second year.	Third year.	Fourth year.
19*s.* 8*d.*	9*s.* 10*d.*	4*s.* 11*d.*	2*s.* 5*d.*

[J. A. V.]

Pampas Grass, a coarse-growing grass, native to the plains of South America. See under GYNERIUM.

Pan, Formation of.—The name 'pan' is given to a hard layer of material which forms at a depth of 4 in. or more below the surface of the soil. It is not to be confused with the layer of rock from which the soil has arisen, sometimes found at this depth; the pan is always produced *from* the soil, the process being really rock formation, and therefore the reverse of soil formation. It is strictly analogous to the formation of sandstones, conglomerate, slates, &c., the chief difference probably being the absence of pressure; and, moreover, as the pan may be very thin, the process is complete in a relatively short time.

Pans may arise by chemical or physical agencies, and show differences corresponding to their method of formation; they are designated by a variety of names to distinguish the different cases. There is, however, a general similarity running through them all.

CHEMICAL AGENCIES.—A pan is formed whenever a substance washing down from the surface soil becomes precipitated in the subsoil and acts as a cement. Three substances are known to act in this way: (1) Certain organic substances, commonly grouped as humic acid; (2) iron compounds; (3) calcium carbonate.

1. *Organic Substances.*—Organic matter, *e.g.* humic acid, may dissolve in the soil water in absence of calcium carbonate or sufficient saline matter, but it readily precipitates. A steadily increasing amount is therefore formed a little way down in the soil, growing round the mineral particles, and finally binding them all together to a hard impervious layer known as 'moor-bed pan'. This occurs extensively under some of the forests in Denmark. It has a red colour, which, however, is due, not to iron as

might be supposed, but to organic matter. In the moorland regions of North Germany a leaden-blue subsoil (*bleisand*, *i.e.* lead sand) occurs under the pan. Both 'lead sand' and pan contain humus substances but not of the same composition; those in the pan contain less carbon and nitrogen, and more oxygen, than those in the lead sand. This type of pan commonly occurs in light sandy soils of acid reaction.

2. *Iron Compounds.*—In certain conditions not definitely ascertained iron compounds dissolve from the upper layer of the soil, wash down, and reprecipitate as a gelatinous mass round the particles a little way below the surface, in the same way as described above. The usual explanation is that the iron compounds of the soil become reduced by organic matter to the ferrous state, and then dissolve in the excess of carbonic acid to form an unstable bicarbonate. This percolates through the soil, but very quickly decomposes with formation of a gelatinous ferrous compound, which rapidly absorbs oxygen and becomes ferric oxide. It is, however, unnecessary to assume any reduction in the upper and oxidation in the lower layers; the solution of iron compounds by organic matter and their deposition when the organic matter changes would be a possible cycle of changes. Such an iron pan is recognized by the fact that the proportion of iron present is higher than in the soil proper. Instances occur in sandy soils deficient in lime. Whether the iron pan or the organic-matter pan is the more frequent case in nature is not yet known. Neither organic matter nor iron compounds dissolve from the top soil if sufficient lime is present, so that pan formation only takes place in its absence.

3. *Calcium Carbonate.*—Cases are on record where calcium carbonate has acted as the cementing material. It dissolves in the carbonic acid in the upper layers of soil and is converted into a bicarbonate; lower down decomposition takes place, and the carbonate is deposited round the soil particles.

Physical Agencies.—Deflocculated clay has considerable powers of cohesion, and may form an impermeable pan in the subsoil if left undisturbed for a sufficient length of time. This kind of pan, often called a 'ploughsole', arises when rather heavy land is ploughed to the same depth for a number of years, and cropped mainly with shallow-rooting plants.

We have seen that the moor-bed pan and the iron pan occur characteristically where the soil is light, sandy, and acid. Such soils are not in any case very good, being much inferior to light, sandy, *neutral* soils. In any case they are liable to suffer from drought, and the pan makes matters worse by interfering with the root range of the plant and with the movement of water in the soil. Further, in wet weather the water cannot get away, but lies in the soil and facilitates numerous changes detrimental to the welfare of the plant.

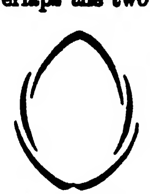
Few improvements are more striking than those that result from the breaking up of a pan, but the process is sometimes too costly to be worth undertaking. Once, however, the pan has been broken, it is not difficult to prevent it forming again if recourse can be had to liming the land. Occasional deep ploughing or subsoiling is also necessary. In dealing with large areas in regions where lime is dear, it may prove more economical to find some timber that will grow, and plant up as wood, rather than to attempt cultivation. [E. J. R.]

Pansy, the popular name of a section of garden violas which have been raised from *V. tricolor*. They are remarkable for their large flowers of many colours, and from the nature of their markings they have been separated into classes known as Selfs, White Grounds, and Yellow Grounds. These again have been divided into show and fancy pansies. So much progress has been made in recent years, especially by German breeders, in enlarging the flowers and improving their coloration, that named varieties of show pansies are scarcely worth troubling about, and seeds sown annually should be relied upon. For further information see under Viola. [W. W.]

Papaver (Poppy), a genus of hardy and half-hardy annual and perennial herbs (ord. Papaveraceæ) with white, yellow, red, and purple flowers, and containing a milky juice. They are widely distributed: four are natives of Britain, being troublesome weeds upon poor land; and a fifth, *P. somniferum* (the Opium Poppy), is naturalized. Opium is the inspissated milky juice of this species, obtained by slitting the capsules; its seeds, which are not narcotic, are sold as bird food. Poppy oil extracted from the seeds is used for cooking, and by soap boilers and painters; it is sweet, and is extensively imported from India; it is also produced upon the Continent. The seeds are also an article of diet. Easy to cultivate, and particularly well suited for a poor, sandy soil, a number of poppies are excellent plants both for borders and for naturalizing. Of the perennials, *P. orientale*, 2½ to 3 ft. high, with vivid scarlet flowers, is the best; the var. *bracteatum* has black blotches at the base of the petals; *P. alpinum*, 6 in. high, has variously coloured flowers, which are borne from May till September; *P. nudicaule* (Iceland Poppy) grows 1 ft. high, with golden-yellow flowers. There are many brilliant annual poppies, some being of mixed parentage. The popular Shirley Poppies are forms of *P. Rhœas* (the Common Corn Poppy), of which there are also double-flowered forms known as Carnation Poppies, Ranunculus Poppies, &c. There are a number of varieties of *P. somniferum*, both double and single, some with laciniated petals; but their period of flowering is brief. Propagation of perennial Poppies is very easily effected by division. Seeds of the annuals should be sown in late summer, where they are to bloom. We particularly recommend the growing of poppies in masses in thinly planted shrubberies. [W. W.]

Papilionaceæ is a collective term applicable to all the leguminous plants which grow in Britain; it indicates certain peculiarities belonging to the corolla of the flower. In the first place, the upper petal (*standard*) differs in size and shape from the two side petals (*wings*), and these in turn differ from the two lowest

petals, which are grown together (*keel*). In the second place, the upper petal overlaps the two side petals, and these, in turn, the two lowest petals, as shown in the diagram.



Floral diagram of Papilionaceous Flower

1. Upper petal—the standard (*vexillum*).

2. Lateral petals — wings (*alæ*).

3. Two lowest petals — keel (*carina*).

Examples of papilionaceous leguminosæ are bean, pea, vetch, clover, trefoil, laburnum, lupin, &c. See LEGUMINOSÆ. [A. N. M'A.]

Paraffin Oil, Use of in Agriculture.—Chemically, paraffin oil is a 'hydrocarbon'—*i.e.* a compound of the two elements hydrogen and carbon only. It is very inert, not being attacked even by boiling acids, alkalis, &c.

Agricultural implements and machinery only used in certain seasons of the year may be conveniently preserved by cleaning with paraffin and smearing over with a cheap vaseline.

Paraffin is widely used as a contact insecticide. As it does not mix with water, and if applied 'neat' in any quantity would be decidedly injurious to vegetation, it can only be used in the form of an 'emulsion'—*i.e.* suspended in water as a multitude of minute globules. Soap is much used as an emulsifying agent, but ordinary flour has been tried recently in America with excellent results.

1. A few formulæ for paraffin emulsions may be advantageously appended:—

Paraffin, 4 pt. (solar distillate).
Soft soap, 1½ lb.
Water, 10 gal.

The soap is dissolved in boiling water, and when still hot the paraffin is added, and the whole mass churned to a uniform creamy consistency by means of a force pump. For winter use the emulsion may safely be made stronger, and 1 gal. of oil used instead of 4 pt.

2. An American recipe, by Mr. F. T. Shutt:

Flour, 5 lb.
Kerosene, 4½ gal.
Water, 36 gal.

This has the advantage of being cheap and easily made. The kerosene is put into a barrel and the flour well stirred in; then about half the total quantity of water is added, and the mass violently churned by means of a wooden dasher. The rest of the water is finally filled in, with thorough stirring. If the emulsion is not to be used at once, rather more flour should be taken—10 lb. in place of 5 lb. will give an emulsion which lasts for twenty-four hours without any settling out of the oil. The addition of a few pounds of caustic soda gives an alkaline emulsion of remarkable stability.

3. A paraffin 'metal' emulsion:

Copper sulphate, 10 oz.
Lime, 5 oz.
Paraffin, 24 oz.
Water, 10 gal.

Such a wash is a fungicide as well as an insecticide.

4. 'Paraffin jelly' is a convenient form of preparation:—

Paraffin, 5 gal.
Soft soap, 8 lb.

The soap and paraffin are boiled together, and, when boiling, about 1 pt. of cold water is well stirred in. On cooling this sets to a jelly. In making up the wash for immediate use, take 10 lb. of this jelly to 40 gal. of water.

Paraffin emulsions should always be applied in a fine spray, by proper spraying machines. Ordinary syringes are of little use.

For pear-midge, drenching the ground under the trees with emulsion when the flies are hatching, has been found beneficial.

Scale disease, due to various scale insects affecting fruit trees and bushes, is often effectually checked by the use of a paraffin emulsion just about the time the young scale insects are emerging beneath the scales. One application is insufficient—the trees should be sprayed once a fortnight for two months. Sometimes a combined wash of paraffin emulsion and sulphur is used for the Mussel Scale.

For aphides on apple trees and Red Spider on gooseberry, paraffin-jelly washes have been found effective if sprayed on twice at an interval of about ten days, so as to catch any of the young hatching from the later eggs. Paraffin washes do not affect the eggs themselves. Cabbages, turnips, and hops have been successfully sprayed with paraffin against 'flea beetle'. A rough-and-ready form of emulsion is sometimes used by shepherds in dealing with 'maggots' on sheep. A mixture of paraffin and water, made up with or without soap, is simply carried about and rubbed over the affected parts with the hand. It is found fairly effective, and has the advantage of being easily obtainable. [H. H. G.]

Para Grass (*Panicum molle*) has within recent years been taken into cultivation, and has become an important forage and pasture grass for rich tropical swamps. The growth is very vigorous and heavy. Para Grass is an underground and surface creeper, often bearing runners 20 ft. long. From these runners hairy, succulent air shoots are produced, which, when left standing, become coarse, tall reeds 4 to 6 ft. high. So productive is the plant that it can be mown every six weeks during summer. When land is to be laid down with Para Grass, cuttings are taken and planted before the rainy season at intervals of 6 to 12 ft. Once in possession of the land, eradication is almost impossible, and this because of the creeping habit of growth. [A. N. M'A.]

Paralysis, partial or complete loss of muscular power, whether of the voluntary or involuntary muscles. The causes are many and various. Division of the spinal cord produces paralysis of all the parts supplied by the nerves passing out from it that are situated behind the breach. Hence we may have an animal paralysed in the hind quarters through the pressure of a broken back, yet breathing and perfectly sensible, seeing, hearing, and desiring to rise, but totally

unable to exercise the voluntary muscles. If the fracture takes place high up in the cervical portion of the spine, death results from paralysis of the vital organs, from which the current has been cut off. Loss of co-ordination results from disturbance of the cerebellum, and unconsciousness or delirium if the cerebrum or brain proper is the seat of mischief. Paralysis may follow on the pressure of a brain tumour, or of an excessive amount of fluid between the membranes and the spinal cord they infest; or the absence of normal blood pressure may cause temporary paralysis, as when an animal collapses or faints from heart failure or hæmorrhage. Narcotic poisons paralyse for a short period; and some, like the Indian Pea (*Lathyrus sativus*), have a cumulative effect which is more permanent. Continued extension of a muscle induces paralysis, temporary as a rule. The distension of the œsophagus when a beast is choked causes paralysis of the muscular layers, which fail to contract upon and carry down the offending body. Paralysis of the lips and of the tail are caused by injury to the nerves of supply. The fatigue of a muscle, which for the time induces paralysis, is taken advantage of by surgeons to perform various operations, as the introduction of the hand into the rectum after wearying the sphincter which guards it. The cremaster muscle which retracts the testicle is wearied by traction before the castrator finds it convenient to operate on adult or well-developed animals. Self-eliminated toxins paralyse, as in hæmoglobinuria of horses, and so-called milk fever in cows; and distemper in dogs, cats, and ferrets is liable to leave imperfect muscular control. Some of the more obstinate forms of constipation are caused by paralysis of the muscular coat of the intestine. The formation of clots in bloodvessels leads to paralysis, as do collections of parasites in particular situations. Blows and falls upon the head, or wounds under the skull, may be followed by paralysis of some of the nerves of special sense; then blindness (see AMAUROSIS), deafness, or loss of smell follow. *Treatment* will depend upon the cause, which we must seek to remove, and the placing of the patient under favourable conditions. [H. L.]

Para Rubber, the original and the most important form of rubber, so named from Pará in northern Brazil. See CAOUTCHOUC.

Parasites and Parasitism (Animal).—Parasitic animals are those that live on or in other organisms from which they derive their food. The host of the parasitic animal may be another animal, thus the adult liver fluke infests the sheep; or the host may be a plant, thus many mites are entirely vegetarian. The parasites may be external hangers-on, *ectoparasites*, such as ticks and lice; or they may be internal boarders, *endoparasites*, such as tapeworms. They may be parasitic throughout life, like *Trichina spiralis*; or they may be free-living in their early stages, like many threadworms and fish lice; or they may be free as adults, like the gall wasps and the horse-hair worms. The parasite may complete its life-cycle in one host, like the threadworm (*Ascaris megalocephala*) of the horse; or it may require two hosts, like the liver fluke or tapeworms. In short, the parasitic mode of life has a great variety of forms and degrees. But the characteristic feature of parasitism is always the same, that the parasite derives its food from its host and confers no benefit in return. For parasitism has to be distinguished from mutually beneficial partnerships (commensalism, &c.) such as often exist between two living creatures of different kinds, though it is quite likely that what began as partnership may end in parasitism. It should also be borne in mind that it is not the interest of the parasite to kill its host—that is like killing the goose that lays the golden eggs—it is better for the adult parasite at least that its host should live as long as possible. Many of the animal parasites of agricultural importance are referred to in special articles, but it may be useful to point out that they represent the following classes: Rhizopod Protozoa, *e.g.* various amœboid parasites; Flagellate Protozoa, *e.g.* Trypanosomes; Ciliate Protozoa, *e.g.* in colon of horses; Sporozoa (another class of Protozoa), *e.g.* Coccidia; Trematodes or Flukes, *e.g.* Liver Fluke; Cestodes or Tapeworms, *e.g. Tænia cœnurus*; Nematodes, *e.g. Ascaris*; Acanthocephala, *e.g. Echinorhynchus*; Hirudinea or Leeches; Acarina (mites and ticks); and Insects.

Parasitism represents a side-track in the struggle for existence. The parasite secures abundant food without much exertion, and it is often very well protected. It is not surprising, then, that the number of parasites should be legion. But the habit is not without its disadvantages: if the parasite lose its foothold in or on its host it is helpless and doomed; the life-history is often full of risks, and the odds against an embryo parasite becoming an adult are often enormous; the habit involves a certain amount of degeneration, proportional on the whole to the thoroughness of the parasitism, particularly as regards nervous, sensory, and muscular systems. The chance of the embryo tapeworm becoming an adult is only one in many millions, and, in adaptation to the enormous risks, parasites are notoriously prolific. A tapeworm may produce 42,000,000 eggs, and a threadworm 64,000,000 in a year. But another way of looking at this is that the rich stimulating diet of many parasites and the degradation of the general life may directly favour prolific reproduction. In any case it may be said of many parasites that if they had not been prolific they would not have survived at all. As to the origin of the parasitic habit, we cannot do much more than speculate; it probably began in various ways—from intimate partnership, from the female's instinct to seek out safe places for reproduction (in many cases the females are parasitic and the males free-living), from a naturally sluggish constitution, or from great keenness in the struggle for existence.

Many skin parasites, such as lice, multiply greatly on their host, but it cannot be said of most endoparasites that they increase their numbers in the same individual animal. They produce abundant embryos, but these usually develop somewhere else. By active migration,

or by being carried in food or drink, they find their way to other hosts. Sometimes they pass by 'self-infection' into the same host, as is the case with some of the threadworms, but this is not usual. In a large number of internal parasites the life-history is complicated by the fact that the embryos pass into a different kind of animal from that which the adults infested, and that they often develop in this 'intermediary host' into a form which is quite different from the adult form. Indeed, the adult form is not attained until there is transference from the intermediary host to the final or 'definitive host'. The embryos of the human tapeworm, *Tænia solium*, find their way into the pig, and there develop into bladderworms, which do not develop further unless the 'measly pork' be eaten by man. The embryos of the liver fluke find their way into the freshwater snail, where they produce, asexually, first rediæ, and then cercariæ, the last becoming liver flukes if they be swallowed by a sheep. In cases like the last-mentioned (see art. Liver Fluke) there is a complex 'alternation of generations'.

A remarkable fact in regard to many parasites is that they are confined to certain hosts; as it is technically expressed, they are *specific* to these hosts. The number of different species of parasites is enormous, and it seems likely that isolation in particular hosts, to which they are severally adapted, has had to do with this. The two commonest human tapeworms, *Tænia solium* and *Tænia saginata*, are in their adult condition confined to man, and this is a familiar illustration of the general fact that in many cases a particular parasite has its particular host and no other. This shows very clearly that the life-histories of parasites correspond to particular routines in nature, especially of nutrition, but also of habit generally. If the same circumstances did not occur over and over again, many species of parasites would soon come to an end. On the other hand, it must be noted that some parasites occur in numerous hosts; the liver fluke and *Trichina spiralis* being excellent illustrations of this. As to the influence of parasites on their hosts, it is difficult to generalize. In many cases parasites do no appreciable harm— a few mites in the skin, a few threadworms in the gut, a few bladderworms in the muscle cannot matter much. Many wild animals that show no hint of any loss of health or vigour seem never without their parasites. The case is different, however, when the parasites become very numerous, like *Ascaris megalocephala* in the horse; or when they find their way to organs like the brain, like *Cœnurus cerebralis* in the sheep; or when they live on blood, like the liver fluke; or when they migrate in the body; as in trichinosis; or when they cause perforations of the gut or lungs; or when they live in the blood. Two lines of recent research are of great interest and importance, but we cannot do more than refer to them. On the one hand, it has been shown that a number of parasitic worms produce definite toxins (leucomaines) that poison their host; on the other hand, it is becoming increasingly evident that parasites not in themselves of great moment may be indirectly very disastrous by serving as the carriers and distributors of pathogenic organisms. [J. A. T.]

Parasitic Bronchitis is more commonly known as hoose or husk. See art. Hoose.

Parasitic Liver Disease in sheep is caused by the liver fluke (see Liver Fluke); in poultry by a protozoon (see Amœba meleagridis).

Paring and Burning consists in removing the surface either by double-raftering, with an ordinary plough, or with a paring- or broadshare, and, afterwards, burning it.

It may be done in the case of foul stubble, but is generally understood to be a preliminary cultivation in the breaking up of downland, old sainfoin, or other descriptions of grassland, in order to bring them into arable cultivation. The objects are the destruction of weeds, and especially of grassy herbage; and of the eggs, larvæ, and perfect forms of wireworms and other pests. The only objection to the system is the loss of organic matter and combined nitrogen, inseparable from combustion; but this may be obviated by taking turnips, rape, or mustard as first crops after cleaning. The first operation, or paring, is done during the winter, and the turf is allowed to lie until March or April, when it is well worked by harrows and rollers. The result is an abundant coat of weedy herbage, which is raked together into heaps for burning. The fine soil is used to cover the heaps and stifle the fires, causing what is termed 'stifle-burning'. The two operations are simultaneous, *i.e.* the heaps are fired, and the heat kept under by shovelling loose and dry soil over the top. After the fire has died out, the ashes are spread over the surface, and the land is ploughed and tilled for roots. The plan has been largely used in breaking up chalk downs for arable cultivation, and is commonly spoken of as 'burn-baking', while the land so treated is commonly spoken of as 'bake' for many years afterwards. Paring was formerly done by breast- or burn-bake ploughs pushed by men from their thighs, which were guarded by wooden shields. The burn-bake plough is essentially a parer, and is furnished with a wooden crosshead which the worker pushes forward as above indicated. These instruments are well known in the chalk districts of Wilts and Hants, but have been superseded by horse parers. The cost of the entire operation is generally estimated at 20*s.* to 25*s.* per acre, but much depends upon the method followed. The process must not be confused with 'clay burning' nor yet with ordinary couching and burning. [J. Wr.]

Paring Plough may take the form of a *Breast Plough* (see above), an implement resembling a plough, but with a very broad share, employed in the practice of paring and burning.

Paris Green, an arsenical compound, used as an insecticide. See arts. Arsenical Washes, Arsenic Compounds, and Insecticides.

Parish.—A parish is the subdivision of the county, whose origin is derived from ecclesiastical practice, whereby a definite district was assigned to the charge of a particular priest, who had the care of souls therein. Subsequently it

was recognized as a convenient unit for the purpose of local taxation and local government, and so the Civil parish was evolved. In England there are now three different kinds of parishes, namely: (1) the Ecclesiastical parish, (2) the Civil parish, and (3) what is known as the Land Tax parish, *i.e.* the district for which a separate assessment of land tax or income tax may be levied. In Scotland the division is twofold, namely, Ecclesiastical and Civil; but the Ecclesiastical parish may be either landward, burghal, or landward-burghal. A landward parish is one which consists of land lying in the country; a burghal parish is one which lies wholly within the boundaries of a burgh; while a landward-burghal parish is one which partakes of both characteristics. The importance of the distinction lies in the different rights and obligations of the ministers, heritors, &c. [D. B.]

Parks, Ornamental.—In regard to the best method of laying out a park, there has been, and ever will be, wide divergence of opinion. The configuration of the situation ought to have an important bearing on the design of the house and park. A tract of flat uninteresting land calls for the use of bold lines indicative of strength and vigour to give life and force to the scene. Here the formal style with its straight avenues has its place. Again, in rough undulating ground with gullies and glens, the natural style with its free curving lines is best.

As the park dominates the general lines of the estate, so should the mansion be the key-note around which the details ought to be arranged in harmony. The primary point will be the selection of a site most suited to the varied requirements of modern civilization, these being convenient accesses to road and rail, water supply, drainage, &c. As modern engineering has overcome most of the difficulties which beset our forefathers when determining a site for their dwellings, the present-day tendency is to select higher and drier situations which command views of the salient points of the estate, or of features in the country beyond. Then the various adjuncts, such as kitchen gardens, carriage stables and estate workshops, dairy and home farm, while being subordinated, should be so arranged as to conveniently serve their purpose without creating any discord in the composition of the picture. Broadly speaking, none of the buildings of these necessary departments ought to be in direct view of the mansion. The planting of trees and shrubs to block out or to screen undesirable features is of vital importance, requiring special knowledge of the trees most likely to permanently serve the object. From a health point of view it is inadvisable to plant rough or large-growing trees in close proximity to the dwelling-house; in fact, no large-growing tree ought to be nearer than fifty yards from a living-room; even when planted as a shelter or windbreak a belt of large trees will better serve its purpose at that distance than one placed near to the house. If trees are required at all, select species of pyrus, hawthorns, and similar-sized subjects. The immediate surroundings of the mansion naturally fall to be treated as the pleasure grounds, with such features as lawns for games, flower gardens, &c., and the trees and shrubs should be chosen and treated as permanent objects of an ornamental character. In the fine keeping of the pleasure grounds, and art of grading from the finer outwards to the rougher parts, is found one of the pleasing features in our home parks' arrangement. Another very important point which demands very careful consideration is that of the approaches or carriageways to the house. Here again the character of the situation constitutes the principal factor. Avoid the error of running an avenue through the park in a straight line at right angles to the front of the mansion. If straight avenues are desired, rather begin them on the same plane as the front, and make them as long and wide as circumstances demand. This course preserves the foreground, which not infrequently is the glory of the house setting. Following thereafter will be the arrangement for the planting of the park in such manner as will eventually best serve the designer's purpose. Primarily the views are to be from the house outwards, and from that point the main lines must be set out. Inward and cross views through the park will in course follow. It is by the careful study of all the peculiarities of the situation that the intelligent planter can, from the vast variety of material now at his command, produce satisfactory and pleasing results. The principal plantations, belts, and groups of trees ought to be set out on bold vigorous lines, and the plants put in moderately close. Thin planting is rarely successful. Avoid too much mixing of the various kinds of trees, as better results will as a rule accrue from grouping each species separately. Throughout the park allow wide free space between the groups, which should vary considerably in size and outline, so that each can develop and show its characteristic in the general composition of the scheme. Carefully avoid the temptation to plant a tree in every open part and thus spoil the effects of light and shade produced by the breadth and mass of the various parts.

Apart from its use as a setting to the mansion in the estate economy, the park is a valuable asset from a utilitarian aspect. However pleasing it may be in general outline, half its charm would be lost were the scene deprived of the presence and movement of animal life, in the form of herds of variegated glossy-coated Ayrshire or Guernsey, the black Angus or belted Galloways, or the picturesquely horned and shaggy-coated Highland breeds of cattle. The grazing of these in a park adds not only pleasure but profit, as not infrequently the value of the grazings compares most favourably against that of the arable land. When subdividing the area for specific purposes avoid the erection of such fences as are crude and obtrusive, and study the direction of the lines towards the preservation of the general amenity. The making or marring of the scheme is due to the attention to minor details.

In the utilization of the park for grazing stock, sheep and cattle are preferable to horses. Many parks throughout the country have been sadly marred by the destruction of the timber

through young horses eating the bark from the root buttresses at the base of the trees. Young cattle when developing their horns occasionally spoil young trees by scarring the stems with their rubbing. Should young horses or cattle be grazed, it follows that protective measures must be used to save the trees from destruction. The attention to fencing, draining, cutting of weeds, liming and dressing the surface, are details familiar to the intelligent farmer or overseer, and come naturally to him as part of his regular duties, not the least of which is the preservation of one of the outstanding features in the landscape of our country. [J. WH.]

Parmesan Cheese. — The Parmesan, which weighs from 50 to 200 lb., is made in Italy, but is well known in England, as in the leading European countries, where it is largely employed for grating and for various purposes in connection with soups and other dishes for the table. It is produced from skimmed milk, about 3 per cent of butter being taken from the milk. The night's milk is left until the morning, when it is skimmed and added to the morning's milk, from which the cream has been taken by separation. The copper vessel in which the curd is brought holds from 20 to 100 gal., and is heated to a temperature over a fire of 86° F. in summer and 98° F. in winter. While heating it is stirred with an implement with a disk at the lower end. The rennet employed is a portion of the actual stomach of the calf in the form of pulp; it is placed in a cloth and squeezed by the hand of the maker, 5 grm. being allowed to 10 gal. of milk. This we thought a dirty process. Coagulation is complete in thirty minutes in summer to sixty in winter. The new curd is broken by an implement known as a panarola, which is used until the grains are fine; the kettle is then moved from the fire, the curd being left to settle at the bottom when a portion of the whey is removed by baling. The kettle is then put over the fire again and stirring recommenced, a small quantity of saffron being added while the curd is cooking, stirring being continued for three-quarters of an hour, when the curd is left to settle. More whey is then removed, a small quantity being left behind to cover the curd, beneath which a linen cloth is placed. When the curd is gathered into the cloth the four corners are drawn together and lifted from the vat into a vessel placed to receive it, where it remains to drain for some twenty minutes before it is placed in the mould, which is made of wood and open at the side, being tightly drawn around the curd by a strong cord. The mould is 5 in. in height by 19 to 20 in. in diameter for cheeses of average size. In North Italy the makers of Parmesan employ no pressure to remove the whey, but cover the curd with a cloth and a wooden disk, when they place it on a draining table, where it remains for a fortnight, being turned several times during the first few days and subsequently once daily. As the curd forms itself into a cheese it is daily washed with brine and finally well rubbed with salt, a portion of which is allowed to remain upon its crust. In its final stage it is scraped from time to time, oiled and coloured, and then remains upon the shelves of the maker or the merchant who has purchased it until it is ripe for the market. [J. LO.]

Parsley (*Carum Petroselinum*), a hardy biennial, native of south Europe. Parsley will grow in almost any kind of soil. It is especially vigorous in sand near the sea. The seeds are sown in drills any time between February and August. In winter the leaves require protection from severe frost. In kitchen gardens it is usual to grow parsley as an edging to borders. It transplants readily, so that the roots may be lifted in October and replanted thickly in frames, where they will continue to develop succulent young leaves for use during the winter. They also may be forced on hotbeds, and market gardeners treat them in this way for a supply of leaves in winter. Round London, for a market supply, the seed is sown monthly from March to August in rich soil, and the plants thinned to 4 in. apart. The leaves are cut, and tied in bunches to be sold by greengrocers, &c., realizing about 2*s*. per dozen bunches. In their second year the plants develop a flower stem and ripen seeds freely by July. The seeds retain their vegetative powers for about three years. There are numerous named sorts of parsley, but they differ only slightly from each other, those mostly preferred having very curly leaves. [W. W.]

Parsley.—Parasitic Fungi. — Downy Mildew (*Plasmopara nivea*) produces a form of damping off on the foliage, and in moist conditions may prove destructive. Celery Rust and Celery Leaf-spot also occur on parsley, the leaves becoming disfigured by brownish spots dotted over with minute black points (see CELERY—PARASITIC FUNGI). *Treatment.*—Avoid overcrowding of plants, and arrange rotations so that umbelliferous crops do not come too close. No definite results have been published as regards spraying, but a spray fluid should check any of the above fungi (see FUNGICIDES). [W. G. S.]

Parsley, Beaked, a genus of plants of the umbelliferous order. See art. ANTHRISCUS.

Parsley, Fool's. See FOOL'S PARSLEY.

Parsnip.—The Wild Parsnip (*Peucedanum sativum*) is a common plant met with throughout Europe by roadsides and hedgebanks, especially where the soil is calcareous. The plant is a biennial, with a strong branched taproot surmounted in the first season with a tuft of large pinnate leaves each with two to five pairs of ovate leaflets coarsely serrated at the margins and downy on the under sides. The stem sent up in the second season of growth is stout, hollow, and furrowed. The inflorescence is of the usual compound umbelliferous type and bears small yellow flowers. The fruit consists of two flattened carpels each with a winged margin and five longitudinal slender ridges, two of them being near the edge of the fruit.

The cultivated parsnip has been grown since the Roman period; it differs only from the wild prototype in possessing a single unbranched fleshy taproot and smooth shining leaves paler in colour than those of the wild plant. The

wild species can be readily modified by cultivation and selection of the seedlings. Professor James Buckman, of the Royal College of Agriculture, Cirencester, sowed seeds of the Wild Parsnip in 1848, and succeeded in obtaining three distinct forms by selection in four or five years; one of these, a hollow-crowned variety, was introduced into commerce about 1860, and is still being sold under the name of the 'Student' parsnip. Several forms are known, viz. (1) The Common variety, with long root and convex, rounded crown; (2) a shorter similar form; (3) the Hollow-crowned or Jersey variety, with long root and concave or hollow crown; and (4) a turnip-rooted form sometimes grown in gardens.

The 'seed' does not retain its vitality very long; samples two years old do not usually contain more than 20 or 30 per cent of living 'seeds'. [J. P.]

Parsnips are not individually mentioned in the crop returns of the Board of Agriculture, but are included in 'other crops', of which there are somewhat under 100,000 ac. in Great Britain. Of these nearly two-thirds occur in the east and east midland counties. The parsnip will do best on the light sandy soils such as are found in some parts of Bedfordshire and other market-gardening districts. There are three distinct types grown, namely, the Hollow Crown, the Long, and the Turnip-rooted. The first mentioned is the most popular, and there are several varieties of it brought out by different seedsmen; of these the Lesbonnais is the best. They are not largely grown as a farm crop, and it is difficult to say where their place should be, but they should come after a crop which has been heavily manured with farmyard or stable manure; no manure should be applied directly to the parsnip. As they do better on freshly moved soil, all the cultivations should be left until the late winter or early spring. The land should be ploughed as deeply as possible, cultivated once or twice, and then harrowed until a fine seedbed is obtained. The seed should be drilled as early as possible in March, in rows from 1 ft. to 15 in. apart, using from 6 to 7 lb. of seed per acre. They should be up in about a fortnight, and when they show the true leaf in about a month from sowing they should be thinned out, leaving the plants about 8 in. apart. The thinning is usually done by bunching with the hoe and then singling by hand. During the summer the crop is hoed both by horse and hand two or three times, according to the cleanness of the field. The crop may be harvested towards the end of October, when the roots are lifted by the fork, the tops cut off, care being taken not to injure the root itself. They are then put in small narrow clamps, about 30 in. to 1 yd. wide, and from 6 to 8 yd. long; in some districts round pits are used. The clamps are covered with straw and earthed up about halfway, the top being left open for a fortnight to allow the moisture to escape, and after this the clamp is finally covered with soil. Another method, and a more popular one, is not to harvest the crop at all, but to leave the roots in the ground where they grow until they are sent to market; then they are lifted, tied into bundles, and sent off. There is some danger that a very prolonged frost may cause injury, but a slight frost not only does no harm, but improves the flavour of the crop. A fair yield will be 12 tons per statute acre. For exhibition purposes, extra fine roots can be grown on fairly heavy soil. The land is well cultivated; a series of holes are made by a crowbar, about 1½ yd. deep and some 6 in. across at the surface. These are filled in with potting soil, decayed refuse, road scrapings, with a little superphosphate and a quick-acting potassic manure. These holes are made in a bed about 2 ft. apart each way. Three or four seeds are sown in each hole, covering them well. When the plants are nicely up they are singled, taking care to leave a plant as near the centre of the hole as possible. By this method, long, large roots will be obtained.

The crop suffers from two insect pests — namely, the Carrot Fly (*Psila rosæ*), and the Celery and Parsnip Fly (*Tephritis onopordinis*). [E. D.]

Garden Parsnips. — Parsnips are grown in gardens in a rich soil, the seeds being sown in March, in drills 18 in. apart, and the seedlings thinned to 1 ft. apart. Although the roots may be grown to a large size, those not more than 9–12 in. in length are preferred for table use.

When once the seedlings have been thinned, parsnips require no further attention beyond keeping down weeds until the leaves begin to decay, or about the end of November, when a portion of the roots may be lifted and stored in dry sand for use when the ground is frozen. But the bulk of the crop should be left in the ground and taken up as required until March, when the remainder should be lifted and stored along with turnips and potatoes. The Parsnip is quite hardy, and the flavour of the root is improved by frost. The variety most grown in market gardens is Hollow Crown. Turnip-rooted is an early variety which forms on the surface like the field turnip, and has comparatively small leaves. The roots are boiled till they are quite soft, and eaten hot with butter, pepper, and salt. They are also largely used for flavouring broth and soup. Next to the potato the parsnip is the most widely grown of all food vegetables by the poorer classes. [W. W.]

Parsnip. — Parasitic Fungi. — Fungi which occur on carrot, celery, and parsley may cause damage to parsnip, either in the form of leaf-spot or as mildew on the foliage, and rot in the edible roots. Hence in arranging rotations in gardens, the crops named should not be grown too near in succession, especially if any of them have been attacked by fungi. Bordeaux mixture, if sprayed on early, will check the diseases. See Carrot—Parasitic Fungi, and Celery—Parasitic Fungi. [W. G. S.]

Parsnip Fly, a fly whose larvæ do much harm to parsnip and celery by mining and blistering the leaves. See Acidia heraclei.

Parthenay Cattle, the designation applied by some official catalogues to a presumably distinct breed of cattle. In reality this supposed breed is merely one of the varieties

of the Vendéenne race, an essentially French breed of cattle originally sprung from the *Bos primigenius*.

Parthenogenesis, the development of an ovum without being fertilized. This occurs as a normal and regular thing in some of the lower animals — in most of the Rotifers or wheel animalcules, in many of the small Crustaceans known as water fleas, and in the summer generations of the green flies or aphides. In the last two cases the parthenogenesis is *seasonal*, it usually lasts through many generations in the warm weather, and it is interrupted by the reappearance of males in autumn. In the queen bee there is *partial* parthenogenesis; she receives a store of sperms from the drone who succeeds in inseminating her; and it rests with her to fertilize or to leave unfertilized the eggs which she afterwards lays. The fertilized eggs develop into workers or into queens (the difference in result depending on the diet of the larvæ); the unfertilized eggs develop into drones. Thus drones have a mother, but no father. What may be termed *occasional* parthenogenesis occurs as a rarity in several insects, such as the silk-moth, where a few of the eggs may develop without fertilization. Worker bees, wasps, and ants are also occasionally parthenogenetic. As an abnormality, the ovum of a bird or mammal may undergo segmentation without being fertilized, but the development never proceeds far. In several kinds of simple plants with slightly differentiated sex there occurs what may be called parthenogenesis, but the only plant with well-differentiated sex organs which shows indisputable parthenogenesis is one of the stoneworts, *Chara crinita*. Only the female plants are found in North Europe, yet the egg-cell develops normally. [J. A. T.]

Partridge (order, Carinatæ; sub-order, Galliformes; family, Phasianidæ).—The Partridge (*Perdix cinerea*) is more familiarly known to Englishmen than any other game bird except the pheasant (see Plate, 'Game Birds', vol. vi).

In plumage and general appearance there is very little difference between the cock and the hen partridge. The yellow-brown feathers on the face and throat of the hen are slightly paler than those of the cock, and do not reach so far back on the cheeks; but the only certain distinction is the colour of the wing coverts, which in the cock are reddish-brown, without bars, and in the hen are darker brown, transversely barred with buff. In September and October, hens can generally be distinguished from cocks by the abrasion of the breast feathers caused by incubation. The legs and feet of young birds remain yellowish in colour until the pairing season in February, when they assume the slaty-blue tinge of adult birds.

Partridges, old and young, remain in the 'covey' or brood till February, when they pair off. Towards the end of April, or more often the beginning of May—about three weeks later than the grouse—the hen scrapes a slight depression in the ground, which she lines scantily with dry grass and leaves, and lays therein from ten to fifteen, occasionally as many as twenty, glossy eggs of a soft buff colour tinged with olive. There is no more devoted or skilful mother than the hen partridge; nevertheless, the young of no game bird suffers so much from the vicissitudes of weather as her offspring. The bulk of the broods are hatched off in June; if the latter half of that month and the first half of July prove wet and cold, multitudes of young birds perish, chilled to death in the growing corn and lush herbage among which they have to seek their food. For the partridge is essentially a denizen of arable land, multiplying in proportion to the amount of cultivation, and diminishing in numbers where cropping gives place to pasture. Yet the arable farmer has no reason to object to a numerous stock of partridges, seeing that of all game birds it does the least injury to agricultural produce, subsisting almost entirely upon the seeds of grasses and of weeds, such as wild mustard, knotweed, buckwheat, &c., varied by blaeberries and other wild fruits, and by caterpillars and insects. Occasionally a few grains of corn may be found in the crop; in hard weather a turnip here and there is pecked into, and in spring some clover crowns may be taken, but the damage done is inappreciable. Nobody has an ill word to say against 'the little brown bird', and its flesh is most delicate and palatable. Careful preservation, assisted in some counties by hand rearing, probably has greatly increased the stock of partridges in this country during the last thirty years or so. The practice of driving originated, as in the case of grouse, with the increasing wildness of the birds, to which the bare stubble caused by modern farm machinery has greatly contributed. The effect of driving has been to increase the number of partridges on the land in the same remarkable degree as has been the case with grouse. In both instances the cause seems to be the larger proportion of old birds killed as compared with the result of shooting over dogs. This is an undoubted advantage to both moor and manor, for it is the invariable instinct of old grouse and partridges to drive away their young and keep the ground for themselves. These old birds are not so prolific as younger ones, hence where there is little or no shooting, the stock of grouse or partridges is sure to fall very low.

The French or Red-legged Partridge (*Caccabis rufa*, Newton) has established itself firmly in the southern counties of England. It has bred occasionally in Scotland, but the northern summer is not hot enough for the requirements of the young brood. The natural range of the species includes France, Spain, northern Italy, and some islands in the western Mediterranean. It was first naturalized in England at the end of the 18th century, and was considered a nuisance by most sportsmen, owing to its habit of running before dogs and its reluctance to take wing. But since the adoption of driving, the red-leg has found much favour, its flight being as swift and generally straighter than that of the common partridge. As a table bird it is not so highly esteemed. In breeding, food, and general habits the two species are very much alike, though the Red-legged Partridge shows a greater preference for heath and scrubby

ground than for arable land. In plumage the French bird is much showier than the British partridge, the cock bird being an extremely handsome creature. The bill, legs, and eyelids are bright-red, the iris orange-red. A black streak stretches backwards from the bill, encircling the eye and curving round to form a gorget beneath the white feathers of the throat. The chest is dun-coloured flecked with black, the breast is dove-coloured, the belly and flanks clear fawn; the back is brown. The feathers of sides, flanks, and thighs are conspicuously barred with dove-grey, white, and black, with an outer margin of orange-red. On the leg is a knob corresponding in position to a cock's spur. The plumage of the hen bird is less brilliant than that of the cock, and she has no knobs on her legs. [H. M.]

Parturient Apoplexy, a disease peculiar to milk cows. See Milk Fever.

Parturition. — Accoucheurs are wont to remind their patients that parturition is not an illness but a physiological act. Other physiological functions are accomplished without distressing the individual, but parturition is accompanied by pain and violent expulsive efforts and general disturbance, even in normal circumstances. Other physiological acts are governed by immutable laws, but this one is subject to many deviations, and no two births are exactly alike. Only a few minutes will be occupied in some instances, while the process will extend over hours and even days in others. There may be a prolonged first stage and a short second one, or the reverse conditions obtain. The contractions known as labour pains differ in intensity, duration, and frequency, as well as in the amount of suffering to which they give rise, and the influence they exert upon other portions of the body. The quantity of fluid (allantoid or amniotic fluid) in the so-called water bag varies greatly. The fœtus presents itself in many ways that do not necessarily impede delivery but are sufficient proof of the variable nature of the act.

During the whole period of gestation the final act has been prepared for. The uterus has been increasing in size, and its muscular layer in particular has been acquiring strength. When the organs necessary for extra-uterine life are approaching completion, changes occur in the womb itself and in the connections which the fœtus has with it. The organic connection between the fœtus and the uterus is gradually destroyed by fatty degeneration, and the blood which has been supplying these structures would seem to be diverted to the udder for milk making. Cell degeneration having reached a certain stage, irritation of the nerve terminals follows, and this again causes contraction, which results in removal of the uterine walls from the envelopes, the fœtus, as Fleming has remarked, being 'like a foreign body in the cavity of the uterus'. The continuation of this process or processes is sometimes irregular, and the final labour pains are retarded when the separation has been premature. The expelling power is chiefly due to the involuntary muscular fibres spoken of, a coat or layer in the uterine wall, which by its dilatation becomes thinner as the pressure of the waters widens the os, and the cervix is indistinguishable from the rest of the uterine cavity. The opening of the os uteri should take place early in labour, and the water bag enter it and act as a mechanical dilator, to which, however, it is predisposed to respond. It is possible to see the os in cows, and it is perfectly round, unless the contractions are irregular from the calf coming broadside. The duration of the labour is largely governed by the time occupied in the dilatation of the os, and this, rather than a small passage and a large fœtus, is the most frequent obstacle. Breech presentations are unfavourable to expulsion, because the neck is directed towards the spine (sacrum). While the water bag and fœtus (assuming a normal presentation of head and fore-feet) are operating in favour of the greatest dilation of the genital passage, the contractions of the uterus from behind continue to aid, and are reinforced by the fixing of the diaphragm, and the muscular action of the abdominal walls.

In the case of twins, each horn of the uterus is about the same size, and its occupant in a similar position as if there were but one in the cavity. We have said that the act of parturition has many variations, and this applies to double conceptions. Both may come head first, or both prove breech presentations. In the majority of cases the first is a head presentation, and the second comes by the breech. The greater distension of the uterus caused by twins, and a consequent weakening of its contractile powers, probably accounts for the slower and more difficult parturition which is usual in animals that are commonly uniparous. Parturition more often takes place before the full period of gestation, and the fœtuses are not so large or strong as singlets. In the case of twins the muscular contractions commence in both horns of the uterus, which contract in a rhythmic, as well as peristaltic manner, and this is aided by the diaphragm which the animal 'sets', and by the abdominal walls; the latter may only be considered as auxiliary to the uterine throes, themselves being the chief factor. These uterine contractions are not absolutely limited to the period or act of parturition; they may occur in diseases of the urino-genital system, and in those curious conceptions in which the fœtus is carried outside the uterus. Labour pains at the commencement are short, the contractions being feeble, and the intervals long. There is a gathering of power — a more forceful effort and better sustained. Each throe commences like a rising wave, and becomes intensified and powerful until a maximum is reached, when it recedes again, and an interval follows in which the animal may seem so indifferent as to commence feeding. At shorter and shorter intervals the pains of labour are manifested until the fœtus is expelled or something abnormal interrupts or suspends them. In malpresentations or impossible labours the contractions grow weaker and finally cease, a point which will be referred to later. The intervals between the pains are necessary to rest the mother, and enable the muscular fibres to regain their power. The intervals also afford time for the genital passage to be prepared by dilation, and a more abundant secretion of mucus, and the

fœtus recovers from the interruption between it and its bed during these contractions. The contractions of the womb by its longitudinal fibres, and the special energy exerted at the fundus, shortening it in the direction of the neck, concentrates force upon the incompressible liquor amnii and forces open the os uteri or narrow constriction, which will be often referred to in connection with delivery. The neck of the womb is shortened, both horns of the uterus acting at about the same time. They are less distantly separated than in unimpregnated animals. Precedence is allowed to the twin most advanced, and the pressure of the second one aids in the expulsion of the first. The interval is not long, as a rule, but there are exceptions, which lend colour to the view of a second conception or superfœtation. The writer has delivered a mummy from a previous conception at the same time as a living calf, and believes that there are circumstances in which one horn of the uterus acts quite independently of the other; as when a second calf is born alive a week after the first, and when no other occupant of the womb was suspected. The interval between the birth of twins in the mare seldom exceeds ten minutes. One or two hours is quite common in the cow, and about half an hour in the case of the ewe. In giving these approximately correct times, we imply normal presentations in which there are no hindrances. Where the latter exist, all sorts of intervals may be observed. In the sow, bitch, cat, rabbit, and other multiparous animals, labour on the whole may be said to be less painful, and calling for less violent expulsive efforts, the young being relatively smaller, if multiple births make as great a total demand upon the strength of the mother. In these animals each portion of the uterus corresponding to a fœtus contracts in its turn, beginning with that nearest the neck, and terminating with the one most distantly placed from it. The horns of the uterus expel their fœtuses alternately. In the third stage of delivery the circular muscular fibres come more specially into action, contracting the uterine cavity in order to expel the contents. It is at this stage that the diaphragm and abdominal muscles afford most assistance in driving the fœtus in what is now the least line of resistance, and the straining efforts resemble those usual in defecation and urination, much exaggerated. Accoucheurs of experience are more or less unanimous in crediting a living fœtus with favouring delivery by his struggles, and it may be that his very circumscribed movements give a stimulus to the mother. On the other hand, the slow delivery of a dead fœtus may be accounted for by the absence of any fixed point in a creature that is collapsed and softened, in some cases decayed. A living fœtus may be taken from a dead mother. Other organs continue to work after the parent's heart has ceased to beat. The uterus has been seen contracting a full quarter-hour after gastro-hysterectomy has been performed. The expelling forces must of course be greater than the resistance offered, and if it is found that these are inadequate the accoucheur will give judicious help.

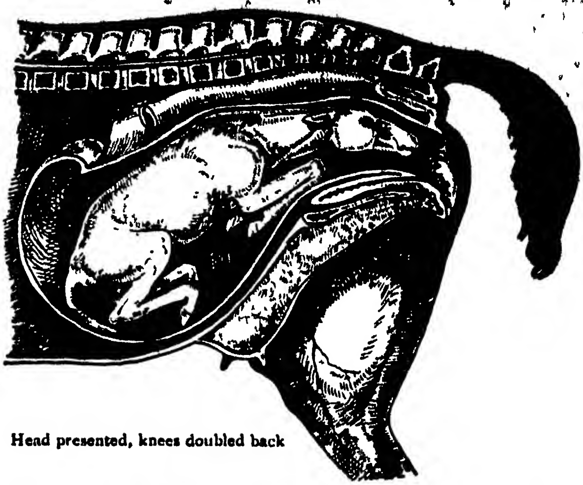
The extrusion of the water bag between the labia of the vagina marks an important stage in delivery, and that with each throe a little more fluid accumulates within it, and distension during the heaving is succeeded by flaccidity in the interval. When the membranes can resist the strain no longer a rupture takes place, some of the fluid falling away, and a part remaining in the vagina to assist in its lubrication. The water bladders may be broken too soon, or the inexperienced person, in his anxiety to assist, make the mistake of puncturing them, with the result that a dry labour follows, necessitating more prolonged efforts on the part of the mother, more or less friction to the passages, and perhaps the death of the fœtus. Those who have charge of pregnant animals should be familiar with the signs of impending labour: the enlargement or springing of the udder, the swelling of the vulva, and increased space between the lips of the vagina—the latter softening, and the lining membrane becoming reddened and covered with a viscid mucus, which in the cow increases to the extent of hanging in a rope from the 'shape' and adhering to the tail and about the hocks. Its presence at the time of parturition is desired for its lubricating properties. Other signs are the pendent abdomen, with croup and flanks falling in; the lumbar region of the spine having a downward inclination, less marked in an animal pregnant for the first time. The haunches get wider apart, or at least appear to do, the modification of the ligaments due to serous infiltration. A listless manner, succeeded by restlessness and evidence of occasional fugitive pains simulating colic; whisking of the tail, bellowing, bleating, whining, and a disposition to seek solitude, are among the signs of approaching parturition. The mare is very near her time when so-called wax candles form on the ends of the teats, and from thenceforward should be under constant observation, but not fussy interference. The larger animals, as well as the sheep, more commonly give birth in a standing position, this being favourable to the effacement of the vertebro-sacral angle and to the action of the auxiliary muscles (diaphragmatic and abdominal), and affording some assistance by gravity when a part (and the heaviest, when the presentation is a front one) has already come into the world. The young creature's fall is checked by sliding down the mother's prominent hocks. There are many exceptions to this general rule, some cows, for instance, giving birth on the ground, and only rising on completion of the act; and many mares going down on feeling the labour pains, which, it will be remembered, in equines are sudden in their manifestation, and very powerful, birth very quickly taking place if the foal is to be born alive. The sow, bitch, cat, and other multiparous animals give birth on the ground. Resting as much on the keel or breast bone, and as far forward as possible, they assume a half circle with their bodies, the head nearing the perineum, and in a convenient attitude for licking the new-born and directing them towards the teat, where warmth and comfort will appease them while the troubled mother prepares to increase the

family. Well-formed sows that have had previous farrows will often expel the young with such force that they turn a somersault. With the multiparous animals the water bag commonly appears only with the first of the litter, the necessary distension or dilation of the passage being thus secured; those to follow are either preceded or followed by their membranes already ruptured. The final separation takes place by rupture of the umbilical cord. The standing position favours this severance, as does the act of rising when birth has taken place on the ground. Mothers have the instinct to bite through an unusually strong cord when licking and clearing the young of the membranes. Wild animals display greater capacity in the care of the young than those which by domestication lose much of their primal instincts. Owing to changes in the bloodvessels in the later period of pregnancy, already referred to, the risk of hæmorrhage is of the slightest, and the tying of the cord now practised at some of the best stud farms is not for the prevention of hæmorrhage, but to shut the door against those malignant organisms which enter the navel during the first few days of extra-uterine life and give rise to navel ill, joint ill, and other diseases. Bitches, too much devoted to their task, will often lick the cord right away and destroy the soft gelatinous navel, rupturing the puppy and perhaps causing its death, or a prolonged and troublesome sore. The cleansing or expulsion of the afterbirth (see Afterbirth) completes the function of parturition.

The variations which may be termed natural or normal have been referred to in a general manner, but the comparative frequency of labour difficulties among the domesticated animals, of malpresentations or dystokia, call for special consideration. These may be trifling, and easily removed, or beyond our powers altogether. The well-trained and experienced surgeon will but rarely fail to extract the fœtus either alive or dead, and in the last resort will dissect it with an embryotomy knife, or perform Cæsarean section, as the operation is called, by which the fœtus is removed through an incision in the side and womb of the dam. If the student, then, will consider well the presentations here described, and note particularly what is shown in the illustrations, he will come to the practical work of parturition mentally equipped in the same sense, but not in the same degree, as the intending sailor who has learned navigation ashore.

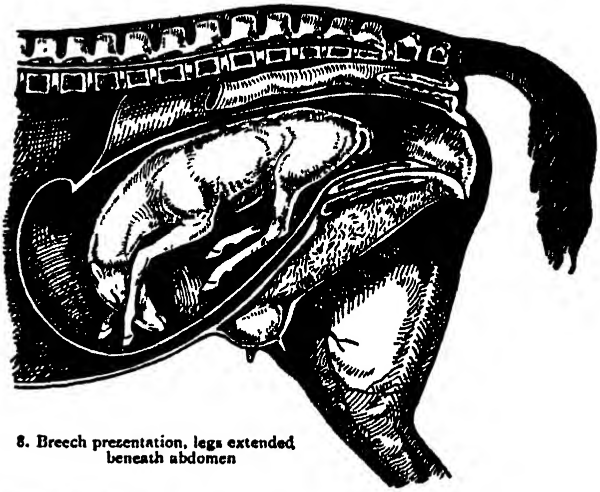
The first figure represents a fœtus presented in the most frequent as well as best position. The birth of such a one, where no interference is needed or permitted, should be carefully observed. There is a temptation to give assistance which must be sternly repressed. Much harm is done by untimely interference, and the most successful practitioners are those who have best learned how to wait. If the water bladders are protruding, we may well wait until they are naturally ruptured. Exceptions to this rule are very rare, as when a doubled limb can be felt, or the outline of one limb so far extended as to suggest the absence of the other, its fellow. A frequent malposition is that of a front leg doubled back at the knee or fetlock, and it may be easily brought into line by a hand previously prepared by paring the nails and dressing with an antiseptic—a precaution never to be neglected. When brought into position the animal should be left to her own efforts, when in all probability the throes will each advance matters a little. If the pains have attained their greatest degree of force and frequency without progress, and there is a disposition to diminution of their power, we may seize the limbs, direct the head, and employ traction at the same time that the animal strains; remitting our efforts in the intervals, unless the case has already gone too long and is a dry labour. Even in the latter case we may use an interval to mix and inject a 5-per-cent warm glycerine lotion, which is a fair substitute for the lost amniotic fluid. The degree of traction permissible is considerable, and many cows recover despite the violence suffered when a horse is harnessed to the fœtus and the poor beast dragged about the floor of the box. A merely superficial knowledge of anatomy will enable the operator to order the direction in which his assistants are to pull on a line, if his own hands are insufficient. If the patient is standing, the direction will need to be downward and backward. Whether standing or prone, the accoucheur should ever have this question of direction in his mind, for he will find the ordinary farm hand pull upwards or sideways or any way whereby he obtains most leverage, and without regard to the position of the poor beast. Cordage should be beyond suspicion of conveying septic matter. Manilla is preferable, as being pliable, but it should not be quite new because then it has fibres standing out which cause friction. Plough lines are convenient in size and for their tapering, but whatever in the way of ropes may be available should receive an ample dressing of an approved antiseptic. A glycerinated carbolic lotion is better than carbolized oil, as the latter is slippery. The coal-tar series, so useful for many other purposes, are objectionable on account of the resin in them. Several convenient lengths of cord are desirable. The ends can be identified by loops, or the number of links in a daisy chain when passed in out of sight. It will often happen that the best way to get up a leg that is turned back, is to push back the fœtus, and this is an act the beginner is most reluctant to perform. He does not like to let a part go out of sight which has once come to the birth. If a cord is hitched upon the pastern he need have no fear of finding it again. There is always room behind. Operating in a narrow passage, with one's hand crushed by the powerful contractions of the beast and the hard head or buttock of the fœtus, is most difficult. If we push him back, a leg or a head can be pulled up. Our hold upon a leg may serve to push about and liberate the opposite one. One of the minor difficulties of delivery is that of a head somewhat sideways, or chin tucked in. With a hand on one ear and another in the mouth, we may often correct this, and ascertain at the same time if the fœtus is alive, for he will almost

1. Natural pre



4 Head presented, knees doubled back

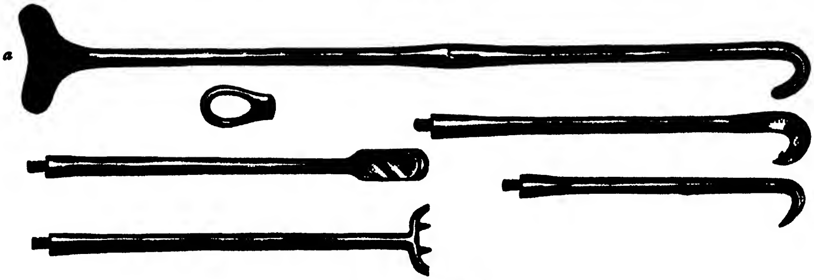
5. One fore limb d



8. Breech presentation, legs extended beneath abdomen

east presented

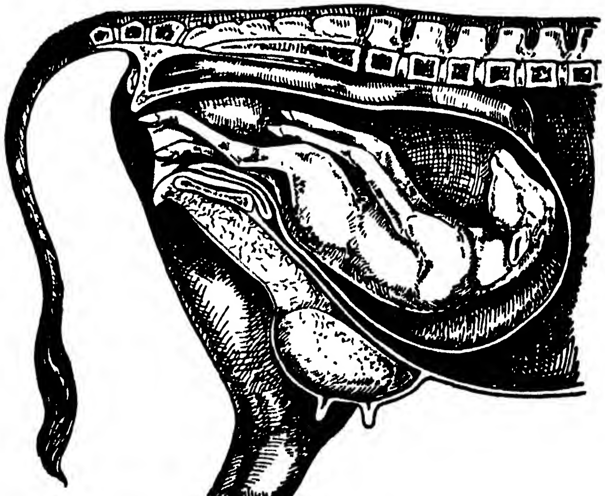
assuredly suck the finger. A difficult presentation to deal with is that of a turned-back head and neck, while the legs are in the passage. Pulling at them is useless. We must find the head, which is probably lying right round against the flank, near the hip. The new-born generally appear to have short necks, but the unborn seem to have very long ones when turned back, as the reader will certainly agree if he has to deal with a case of the kind. In these circumstances, and others to which we shall have occasion to refer, an implement in the nature of a crutch is of great value. We may extemporise one by detaching the metal from a spade. When disinfected we carry in the handle and press against the other end with the shoulder, taking



Gowing's Parturition Instrument. a, Crutch or repeller.

advantage of what displacement we can thus gain to work our hand to the head of the fœtus. We may reach an ear with difficulty, or be compelled to press a thumb into an orbit to slew the head a little, until we can get a good purchase with a finger and thumb in the mouth, when we may hope by one or more efforts to get the head up. It often happens that one's arm gets paralysed with the pressure and must be withdrawn, and for this reason among others we should learn to use both hands or we may find our labour lost, and the fœtus in the same position as at first, when our rested member is again introduced. An assistant at the flank may help us by the pressure of his hands or knee where we can direct him to apply it. The head can often be felt through the abdominal muscles. The cords upon the limbs can then be used to bring the front legs into line, as in the first figure. They must be placed a little in advance, and before we get the head into the passage. It is at the chine or wither that the greatest pressure comes, after the head is born, and then, having the shoulders outside, very little resistance is offered by the hind quarters. If the hind legs are presented all may go well, and such an attitude is not considered abnormal, especially when the second of twins; or in the case of multiparous animals, where a fore and aft presentation alternately would seem to be the general rule. The extremities are much alike, and the accoucheur will satisfy himself as to which feet are showing. He should be able to tell a hock from a knee. Both have a little bone prominent at the back, but the os calcis is longer, and a finger can be inserted between it and the hamstring sufficiently to distinguish it from the trapezium. A little further exploration and the tail will be found, and by its position tell us whether the fœtus is on its abdomen, back, or side. If coming in the fashion depicted in fig. below, we have only to wait developments, as advised in a normal head presentation. A very difficult case to deal with is that in which the rump is felt pressing against the passage, without the possibility of entering it, and the legs are not to be found.

The fœtus may be standing as it were in the

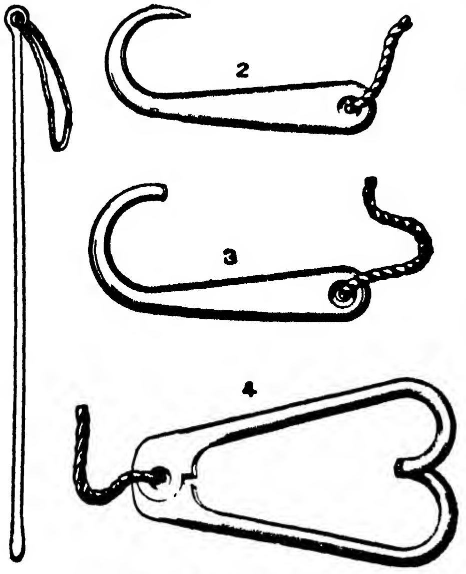


Calving: all four legs presented. Calf on its back

belly, or his back and legs in the same position of that of his dam. He may be sideways, and, in the absence of any mane by which to distinguish one portion of the back from another, we may be groping between the shoulder blades and mistaking them for hams. By pushing back the fœtus, and patient exploration, we are sure to presently find some object by which we may decide at least what portion we have to deal with. It may be well to give the patient a

stimulant while we develop a plan. It is possible, but not easy, to turn the young creature, or at least secure some member by which we can proceed on the lines previously laid down; always remembering that there is room where the fœtus came from, and that we need not fear to let a noosed limb out of sight.

Hooks, both blunt and sharp, attached to cords or screwed into metal stems are employed by veterinary surgeons, who know how to introduce them and insert them without much risk to the mother; but they should scarcely enter into the armamentarium of the non-professional accoucheur who can do many wonders with cords, and that best of all instruments the human

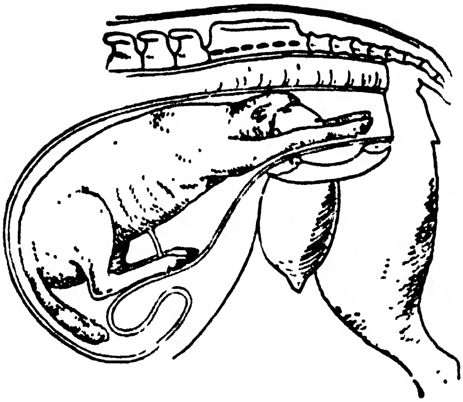


1, Porte-cord. 2, 3, 4, Hooks or crotchets (2, Sharp. 3, Blunt. 4, Double.)

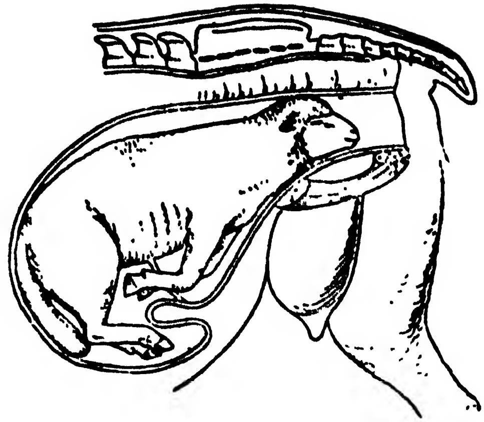
hand, intelligently directed. During the latter portion of life in the womb the fœtus often makes violent movements—a fact so well known that the rough test of pregnancy often adopted is to give a deep draught of cold water, which provokes the creature to spasmodic jerkings easily observed in the flank. Heifers are sometimes very much frightened, and the fœtus gets into, and appears to remain in, a very awkward position. These leaps may possibly account for one of the difficult labours which at first is positively appalling to the inexperienced. We refer to the presentation of three feet in the canal. Unless a monstrosity has to be dealt with, it is obvious that they cannot all belong to the same end of the creature. They are more or less crossed, and completely occupy the canal. They do not belong to different fœtuses, although we have heard of such a case. Carefully examined, there will usually be found two out of the three more closely resembling each other, and nearer to parallel than the third. If our hand can be passed up far enough, we may distinguish by the hook bone, already spoken of in another form of presentation. Once we have made out whether the odd leg belongs to a front or hind pair, we can proceed on the probable least lines of resistance. A line with identification mark had better be hitched round the pastern, and then the limb may be pushed back over the brim of the pelvis. If the pair of legs left belong to the hind part so much the better for us: the fœtus will turn over probably when we have made a little progress in pulling the limbs into the genital passage, and it will be a comparatively straightforward job delivering him. If, however, we have two front feet left, we may be pretty certain to have all the trouble in getting up the head which we have already described in connection with anterior presentations. We have now indicated some of the typical cases of dystokia, but there are, besides, a countless number of attitudes between them which call out the resourcefulness of those engaged in the breeding of farm stock.

Monstrosities, and what are known as impractical labours, require all the skill of the experienced veterinary surgeon, who may have to resort to an instrument called an embryotomy knife to separate the limbs and extract the fœtus in parts. This knife is carried inside and opened when there, thus avoiding some risk to the mother. In the absence of such a tool, and if compelled to act without professional assistance, the stock-owner may succeed with an ordinary short-handled and short-bladed castrating knife, which must be introduced open. It can be concealed in the hand, the point covered by the forefinger and the cutting edge kept towards the fœtus. It is work calculated to try the nerve and fortitude of anyone, but can generally be carried out by patient effort. We have seen it attempted as a butcher would cut a joint. The operator cannot get round it, and fails. The most promising method is to make as long an incision through the skin as the situation of the fœtus will permit, and work under from either side. If a hip joint can be got at, the severance of the ligaments at the cup-and-ball joint is comparatively easy. The same may be said of a shoulder. When a limb has been removed, there should be room to work for another; but the pressure from behind always seems to rob the operator of any favour he may have looked for, and the crutch should be used. Decapitation should be performed between the occiput and first bone of the neck, and no bone should be broken or divided by the saw, for fear of wounding the mother in the outward passage of the dismembered fœtus. Some dropsical bellies offer much resistance to delivery by their great volume. These should be laid open and the fœtus eviscerated, without puncturing the gut or wounding of other organs whereby their contents might escape into the womb of the mother. There is much risk of wounding, or at least of abrasions, the latter being caused by friction from cords, and not suspected; extra precautions in the way of antiseptic irrigations should therefore be adopted where embryotomy has been unavoidable. After delivery, the needs of the mother will vary according to the difficulties encountered, the

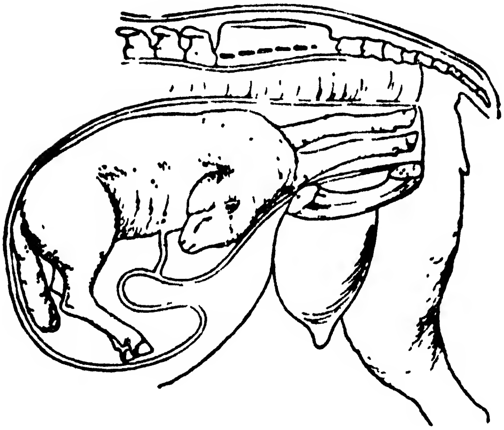
PARTURITION—II



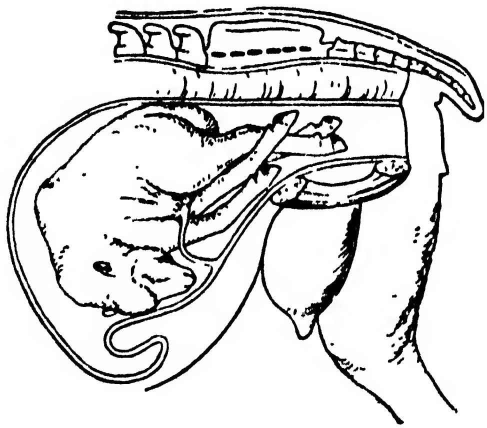
1. Ordinary head and front legs presentation



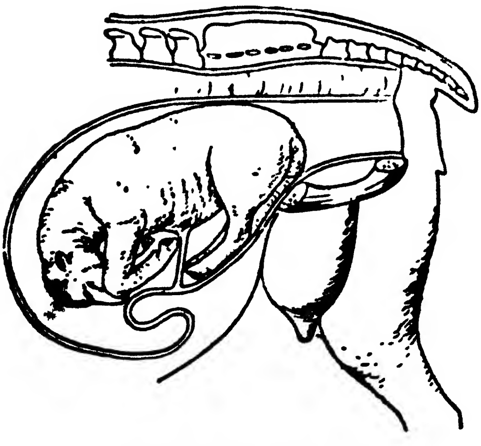
2. Head in right position, but legs down



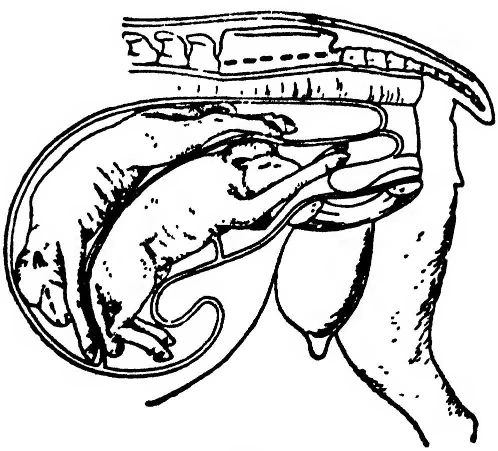
3. Legs in line, but head turned back



4. A case to be turned over



5. Breech presentation, with legs down



6. Twins

PRESENTATIONS IN THE EWE

strength, temperament, and species to which she belongs. After a natural labour, and in a vigorous animal, good hygienic conditions are all that is necessary. It is important to remember the peculiar susceptibility of parturient animals to bad air and evil smells, and to chills and sudden lowering of temperature which result from cold draughts of air. Clean bedding, on a floor previously disinfected, should have been prepared for the mare or cow, and fresh litter should be given after delivery: taking away what is soiled, with care not to disturb the lower layers for the moment, as with rare exceptions a bad odour is provoked. If the whole bed needs removal at once, disinfection must be thorough, and it will distress the mother less to be quietly removed to a fresh box where no amniotic fluid has soiled the bedding. The mare and cow may sweat during parturition, and should be whisped dry or covered with clothing, and, having been made comfortable, left for a while to compose themselves after the recent excitement. Some gruel or bran mash may be offered, and if rejected it should be removed, and a fresh supply given when revisited. Stimulants in gruel enable an exhausted beast to rally; and of these whisky for the mare or cow is most favoured, and sweet spirit of nitre for the ewe, or brandy with ether and a small dose of laudanum. What has been said of the cow applies for the most part to the ewe, as a ruminant, but goats often endure prolonged labour and encounter more difficulty in parturition generally. We have spoken of the great susceptibility of parturient animals to septic invasion, and this applies with greater force to the ewe than to any other species of domesticated animal. The ewe is specially liable to septic metritis, peritonitis, and blood poisoning, and it will be generally agreed by flockmasters that the lambing pen with a southern aspect, and protected by hurdles plaited with straw, or some of the modern folding fabrics, will give better average results than yeaning in buildings or stenched bartons and shaded orchards. While not subscribing to the popular belief that pigs love dirt, and desiring for them good dry clean beds, we may point to warmth and protection from the elements as more necessary than anything else—a matter in which they differ so completely from the sheep. Not much litter, and that very short, should be supplied to a sow about to farrow. She will be put to the trouble of scraping it away if abundant, and if long the young pigs hang up in it and fail to reach the teat, or get crushed by their mother because unable to get out of the way when she lies down. Sows, bitches, rabbits, and ferrets are prone to destroy and eat their young when disturbed, and should be left for a few days with as little interference as possible. [H. L.]

Pasteurization.—The heating of milk to a temperature sufficient to destroy practically the whole of the adult forms of micro-organisms, and below that at which marked changes in the chemical and physical properties occur, is called pasteurization. The term is derived from the late Louis Pasteur, who was the first to point out the rational use of heating beverages to destroy the organisms causing fermentative change; he did not, however, devise any special method for milk. No sharp distinction can be drawn between the pasteurization of milk and its sterilization, but it is now generally accepted that milk is pasteurized when it is heated to a temperature not exceeding 165° F. for a period of twenty minutes or less. Many contradictory statements as to the efficacy of heating to various temperatures for differing lengths of time have been made, but the experiments of Babcock, Russell, Hastings, and other workers at the Wisconsin Experiment Station have gone far to reconcile these. The American investigators have shown that it is necessary to agitate the milk during the heating in order to free the micro-organisms from the protective skin formed, and that a degree of heating ample to destroy the germs of tuberculosis if thorough agitation is performed is quite inefficient when the milk is at rest. They succeeded in pasteurizing milk at as low a temperature as 140° F.

The use of pasteurization gives the following advantages:—

1. The milk being practically freed from lactic-acid organisms, will keep for a much longer period before going sour than if untreated.

2. Pathogenic organisms (with the unimportant exception of the bacillus of anthrax) are all destroyed by proper pasteurization, including the bacillus of tuberculosis, which is sometimes present in the milk of diseased animals.

There are, however, drawbacks, which to some extent counterbalance the advantages.

1. The cream rises in a different manner, and the total layer on pasteurized milk is only about half that on unpasteurized milk; to the eye, pasteurized milk may appear poor.

2. Certain chemical changes, very small in amount, and difficult to satisfactorily establish, take place on heating to 160° F. or above; these cause a small loss of the so-called vitalizing properties of milk, and Coutts has even brought forward evidence to show that periostitis has been developed in an infant predisposed to this disease which was fed on pasteurized milk. Generally speaking it does not appear, however, that the loss of nutritive properties on pasteurization is appreciable.

3. For some hours after milking, the number of micro-organisms in raw milk decreases, possibly due to the presence of leucocytes or other living cells; after pasteurization no decrease occurs, the cells presumably having been destroyed by the heat employed.

4. The lactic-acid organisms having been destroyed, the particular fermentation which takes place is determined by the organisms which first find access to the pasteurized milk, and sometimes unpleasant flavours are developed by the growth and action of micro-organisms, which would have been held in check and overgrown by lactic-acid germs had they been present.

As a general rule, it is held by the majority of those qualified to judge, that the advantages of pasteurization of town supplies outweigh the drawbacks. If a supply of milk from perfectly healthy cows, marketed under the best hygienic

conditions and properly certified, can be obtained, this would undoubtedly be better if supplied raw than if pasteurized; under this system a very large increase in the cost of production is inevitable. An uncertified supply can be safeguarded by pasteurization at a cost which is largely met by the saving due to decreased waste by souring.

Milk is not usually pasteurized on a small scale on account of the difficulty of keeping the temperature constant for the requisite period, and of agitating the milk. On a commercial scale a continuous method is generally adopted: the milk is run over a heated surface, or through pipes which are immersed in a heating medium, or it is run into a vessel which can be heated, and in which the milk is stirred, in a continuous stream, the rate of flow of milk and the supply of heat being so adjusted that the milk is heated to 160° F. or thereabouts; vessels of sufficient capacity, which are insulated to prevent loss of heat, and through which the heated milk slowly flows, are often provided to keep the milk at the desired temperature for the requisite period. The milk is cooled to as low a temperature as possible on exit from the pasteurizer, and it should be received in clean and sterile vessels, in which it can be protected as far as possible from bacterial contamination.

The regenerative principle is often applied to lessen the expenditure of heat; the cold milk is partially heated by the pasteurized milk, which is thereby cooled to an equivalent degree. This is done by running the two streams of milk in opposite directions on either side of a good conducting septum, and in a good form of regenerator both the heat required to raise the temperature, and the water or other cooling medium, are reduced to a minimum. [H. D. R.]

Pasteurizing Plant.—Of the many forms of pasteurizers one of the earliest was the Lawrence. This was a modification of the Lawrence cooler, and consisted of a double corrugated surface, suspended vertically, and in the interior of which a current of steam-heated water circulated. The milk ran into a trough at the top, and by means of small holes was distributed on to the corrugations, on flowing over which in a thin stream it was rapidly raised to the desired temperature. This type is not greatly to be recommended, because it exposes a very large surface to the air; because any check in the flow of milk causes the milk to dry on, rendering cleaning difficult; and because the time of heating is very short. It causes a diminution of the number of micro-organisms to the extent of about 99 per cent.

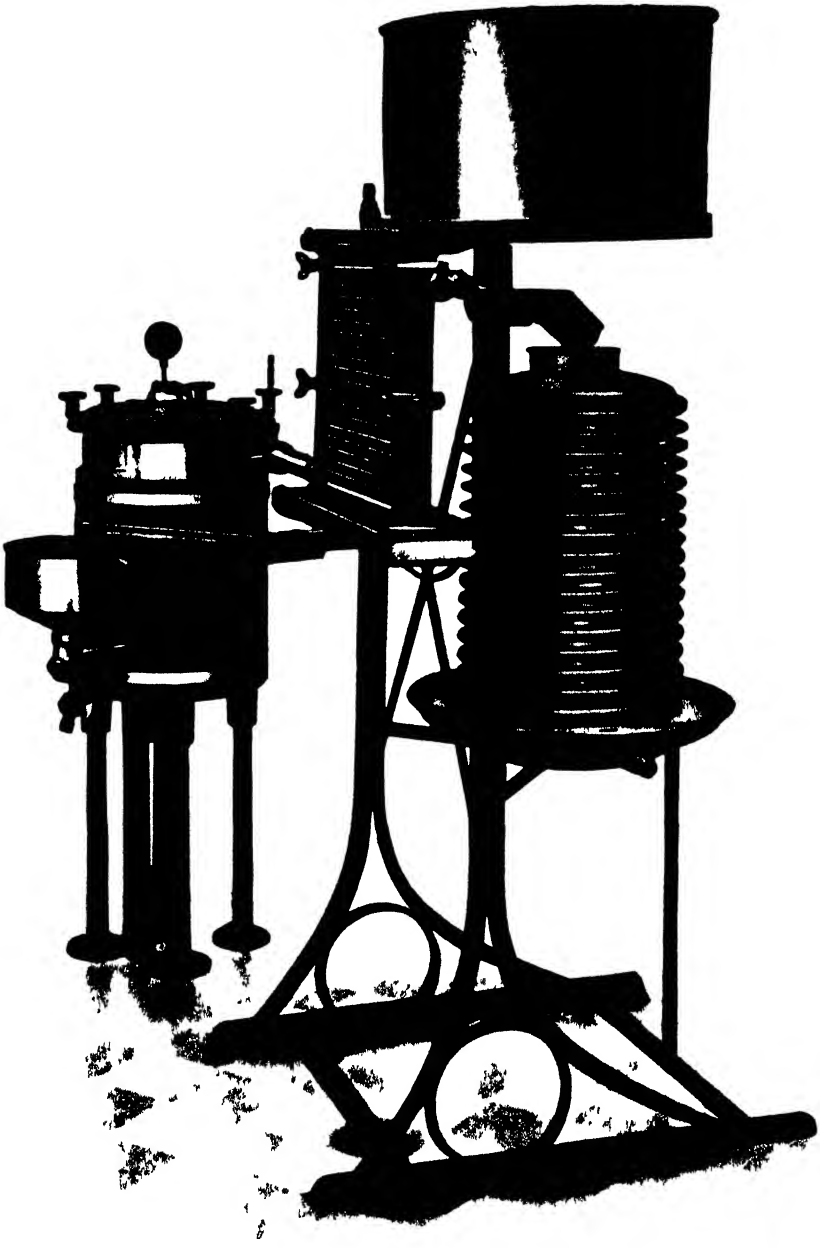
A very usual and efficient type of pasteurizer consists of a steam-jacketed deep cylindrical vessel, furnished with a rotating stirrer. The milk enters the bottom of this, and is heated by the steam jacket, which usually does not extend more than about three-quarters of the way up; the milk flows from the top. This type may be open, or may be covered with a loose lid, or, as is now more usual, closed by a screw-down cover. If the stirrer is made helical, the milk can be raised after pasteurizing to a considerable height in a closed apparatus. By suitably adjusting the rate of flow, the milk can be kept at the necessary temperature in this form of pasteurizer for any desired length of time.

Another type consists of a series of coils through which the milk passes at a rapid rate, immersed in water which is kept at or near the boiling-point. In a recent apparatus a strong solution of calcium chloride is used as the heating medium; and this has the advantage that the requisite temperature can be maintained without steam being given off. This apparatus is generally heated by gas. To maintain the temperature for any length of time, an auxiliary insulated vessel is necessary.

The Farrington pasteurizer is a very ingenious one. In this the heating is performed by a series of hollow disks filled with steam-heated water, which are continually rotated in a vessel through which the milk flows. The heater is usually connected in series with a cooler of the same type in which cold water flows through the disks.

Pasteurizers are generally used in conjunction with regenerators. These are of the general type of milk coolers in which the cold milk flows over the outer surface, and the pasteurized milk flows within, in the place of the water in the cooler. There are three types which may be mentioned. One resembling the Lawrence cooler, but in which special provision is made for cleaning the interior, either by making it open like a book, or by providing it with detachable ends. This type is usually independent from the pasteurizer. A second type is like a cylindrical milk cooler, and generally fits over the pasteurizer. In this there is an outer corrugated shell which fits over the outside of the pasteurizer, the steam jacket of which is placed in the interior. The milk flows over the exterior, is collected in a small tank, from which it is pumped to the pasteurizer, and flows from thence into the interior of the corrugations. The last type is the Defries pasteurizer, which consists of a series of double pipes set vertically. The milk is taken through the space between the inner and outer pipes, which at the top of the apparatus pass through a heating chamber, and the hot milk returns down the inner pipes, which at the bottom are surrounded by a cold-water jacket. This type of apparatus contains the pasteurizer, regenerator, and cooler all in one. [H. D. R.]

Pastoral Farming.—Many parts of the country are not suitable for the plough, and have to be devoted to the grazing of sheep or cattle, or in some cases both. Thus, in addition to arable farming, where the tillage of the soil and the growing of crops are the main objects of the farmer, and dairy farming (see article), where the production of butter or cheese is practised, there is pastoral farming, involving the breeding and rearing of sheep and cattle, and in some cases the preparation of these, especially the latter, for the butcher. Owing to the difficulty of making wheat-growing pay during many years past, great stretches of land which had been cultivated for generations have been laid down to pasture, and are now used for feeding cattle. But besides these pasture lands there are many millions of acres in Great Britain which, on account of their



65

COMPLETE PASTEURIZING PLANT

The milk is poured into the m[illegible] It then passes through a filter and over the Regenerative Heater [illegible] Pasteurizer. From the Pasteurizer it returns and passes through the Regenerative Heater from below upwards and finally over the milk cooler. Thus the cold milk flowing over the surface of the Regenerative Heater is partially heated by the hot milk ascending through the Heater from the Pasteurizer, and in this way an economy of steam and cooling water is effected.

steep and rugged nature, and in many cases the altitude at which they are found, are utterly unfit for the plough. These upland regions are the habitat of the mountain sheep, and the pastoral farmer devotes his time and energy to the management of such lands and the stock they carry. Sheep and cattle farming requires as much skill and enterprise as any other branch of agriculture. A general acquaintance with the principles of breeding is absolutely essential, and to secure success much practical experience and sound judgment are necessary. The risks attending the pastoral farmer's calling are great. The storms of winter and the droughts of summer are equally causes of extreme anxiety, and can only very partially be provided against.

Lowland pastures, which for the most part, as has been indicated, are devoted to the grazing of cattle, tend to improve if there is a liberal supply of cakes or meals given along with the grass, and some feeders also apply topdressings of artificial manures. Attempts to improve ordinary hill grazings have not been particularly satisfactory, but there is no doubt that an application of 10 cwt. of slag per acre on certain classes of moorland will fully repay the outlay. Manuring with 3 or 4 cwt. of kainit or muriate of potash has also been found very beneficial in some instances. Many of the farmers of the past generation limed their hills. The results were profitable for some years, but the parts then treated are in many cases the poorest now. Hill pastures are, however, much improved by judicious draining, and there are few farmers who do not realize the truth of this. Another point on which stress must be laid is the necessity of keeping a stock not too large for ground to be grazed. Overstocking, which is always a temptation to the unwary and inexperienced, is one of the greatest mistakes a farmer can make; and a farm will give the best return when it is carrying a stock under, rather than over, its full complement. Pastoral farms in Great Britain vary greatly in extent—from a few hundred to several thousand acres. In the case of the smaller holdings the farmer himself may look after all the stock, or at most have the assistance of one shepherd, but there are not a few sheepwalks, especially in the northern counties of Scotland, where seven, eight, or even ten shepherds are employed.

On purely pastoral farms very simple buildings are required, as compared with what are necessary on arable or dairy farms; but in almost every instance a substantial hayshed should be one of them; and no effort should be spared by the farmer or the shepherd to have it filled before the short, cold, stormy days of winter come round. The capital required to stock pastoral farms varies greatly according to the locality in which the farm is, and the kind of stock carried; but speaking generally the rental of the farm multiplied by ten will be sufficient capital for most farms in the south of Scotland; but in the north, where the rents are low and the 'valuations' high, twenty times the annual rent will often be required. [W. E.]

Pastures (Permanent), Improvement of.—Up till the last quarter of the 19th century almost the only means adopted for the purpose of improving pastures were the application of lime and, in certain districts, of bones. But almost from the date of its introduction to the British market in 1887, basic slag came to be preferred to all other substances as a manure for pasture land; and its abundant supply, and cheap cost, have led to a much more extensive manurial treatment of pastures than had ever before been known. Since 1897 numerous experiments have been conducted in Britain with various phosphatic manures, with lime, and with nitrogenous and potassic manures, applied in various forms and combinations to poor pastures on all kinds of soils, and under various conditions of rainfall and altitude. In all of them it has been found that the use of nitrogenous manures was not desirable; that lime was much too slow in its action, and in the first years of application was sometimes even injurious; that bones were distinctly less effective; that superphosphate was less profitable on account of its greater cost; and that basic slag applied alone, or in some cases along with kainit, in every instance proved itself to be the most profitable manure to employ. On no kind of pasture has it been found ineffective, though the amount of increase produced has varied very considerably with the nature of the soil. Its maximum results have been produced on clays and on peaty soils, and on damp and sour meadows. On light dry soils its influence has been less marked, but even on them it has improved pastures both in yield and in nutritive quality. On some soils an application of the slag has been followed by an extraordinary growth of White Clover, so that fields became covered with masses of clover blossom, where previously the clover plants had been so small and stunted as to be rendered almost invisible by the overshadowing grasses. Wherever this has occurred the application of the slag has proved specially beneficial, on account of the enrichment of the soil in nitrogen, which has resulted from the abundant growth of the clover. On a clay field in the Northumberland Experiment Station at Cockle Park where this effect was singularly well marked, a 3-ac. plot that had received 10 cwt. per acre basic slag (38 per cent) still carried in the ninth year nine sheep as compared with four sheep on the untreated plot, while the profit realized in the nine years from the application of slag amounted to £10, 0s. 3d. per acre. On other soils, while the appearance of the herbage has been less notably changed, the quantity and quality have been invariably so improved as to enable the pastures to carry more and better stock. The addition of kainit has given irregular results, depending on the nature of the soil. On land overrun with fog the use of slag and kainit together has been found to destroy it almost completely, while on light soils the addition of the kainit has also proved generally advantageous. It is, however, on pure moss land that the combination of the two manures has given the most striking results. On a pasture on reclaimed moss at Midlocharwoods, in Dumfriesshire, in one of the West of Scotland experiments, a plot that had received 10 cwt. 92 lb. basic slag

still carried eight sheep in the sixth year after the manures had been applied, as compared with six sheep on an untreated plot, while that which had received 8 cwt. kainit in addition carried ten sheep. In six years the profit from the basic slag was calculated to amount to £1, 7*s.* 8*d.* per acre, while where the kainit was added to the slag the profit was increased to £1, 19*s.* 6*d.* The quantities of basic slag usually given vary from 5 to 10 cwt., and those of kainit from 4 to 8 cwt., per acre. As a rule, better results have been obtained from the single large application than from the divided and repeated dressings. The improvement effected by the manures is usually more visible in the second year than the first, and it may continue for a period of from five to ten years. The manurial dressing may be repeated in seven years. The ultimate effect of basic slag applied alone to pastures, like that of lime, though in a less degree, is exhaustive, except on those soils where it produces a large increase in the leguminous herbage of the pasture. But the improved condition of the soil may be maintained by feeding the stock kept on the pastures with liberal supplies of cake and corn to enrich their manure. [R. P. W.]

Pastures — Seeding, Formation, and Management of.—Before proceeding to consider in detail the seeding of pastures, it may be profitable to enquire into the plants most suited for pastures.

The best pasture plants are those which are most lasting, most productive, most readily eaten by stock, and most capable of holding their own against intrusive weeds and natural grasses. By productive is meant the possession of tillering power to a high degree, and the capability of producing a great number of large broad leaves, which is possible only when the roots are numerous and penetrate deep into the soil. Cocksfoot and Timothy, for example, meet these requirements on soils which suit them; but Yorkshire Fog and Sweet Vernal do not, for stock are very averse to these plants, and do not browse them unless compelled by hunger. Lucerne again, though productive and readily eaten, is quite unsuitable, for it cannot grow in association with other plants, and is at once ousted by them. In addition to lasting productive plants, others of diminutive size are required to form 'sole' or 'bottom', to fill up the gaps between the large productive species, thus forming a complete sward. Crested Dog's-tail, for example, is a good sole plant if eaten early, whereas Perennial Rye Grass is defective for this purpose, because it soon dies out and allows weeds such as Yorkshire Fog to obtain a footing, and ofttimes too much predominance. When the soil is thin, it cannot carry the large and deep-rooted plants; in such cases the whole pasture is reduced to bottom herbage.

Nitrogen gatherers, namely leguminous plants, are useful in pastures because they are not only browsed, but change the elementary and useless nitrogen of the soil atmosphere into the combined and useful form. We now give a classified list of all those plants which experience has shown to be useful for pasture purposes.

1. Top Grasses (productive and deep-rooting, with large leaves)—
   - Italian Rye Grass (*Lolium italicum*), shortlived.
   - Timothy (*Phleum pratense*).
   - Meadow Fescue (*Festuca pratensis*).
   - Rhenish Tall Fescue (*Festuca elatior*).
   - Cocksfoot (*Dactylis glomerata*).
   - French Rye Grass or Non-bulbous False Oat Grass (*Arrhenatherum avenaceum* var. *non-bulbosum*).
   - Meadow Foxtail (*Alopecurus pratensis*).
2. Bottom or Sole Grasses (leaves small and narrow)—
   - Perennial Rye Grass (*Lolium perenne*), usually shortlived.
   - Crested Dog's-tail (*Cynosurus cristatus*).
   - Golden Oat Grass (*Avena flavescens*).
   - Smooth-stalked Meadow Grass (*Poa pratensis*).
   - Rough-stalked Meadow Grass (*Poa trivialis*).
   - Hard Fescue (*Festuca duriuscula*).
   - Sheep's Fescue (*Festuca ovina*).
   - Various-leaved Fescue (*Festuca heterophylla*).
   - Creeping Fescue (*Festuca rubra*).
   - Fiorin (*Agrostis alba*).
3. Leguminous Plants (nitrogen gatherers)—
   - Red Clover (*Trifolium pratense*) } not lasting.
   - Alsike Clover (*Trifolium hybridum*) } not lasting.
   - Trefoil (*Medicago lupulina*) } not lasting.
   - White Clover (*Trifolium repens*).
   - Bird's-foot Trefoil (*Lotus corniculatus*).
   - Marsh Bird's-foot Trefoil (*Lotus major*).
   - Kidney Vetch (*Anthyllis Vulneraria*).
4. Miscellaneous Plants—
   - Chicory (*Cichorium Intubus*) } nat. ord. Compositæ.
   - Yarrow (*Achillea Millefolium*) } nat. ord. Compositæ.
   - Burnet (*Poterium sanguisorba*)—nat. ord. Rosaceæ.

The top grasses are tufted in their growth, except Meadow Foxtail, which is slightly creeping or loosely tufted. Italian Rye Grass is suitable only for hay production, and Cocksfoot only for pasture, not for hay. The grasses specially suitable for heavy land are Timothy and Meadow Foxtail, whereas French Rye Grass is specially suitable for light land.

The sole grasses are sometimes tufted in their growth—Perennial Rye Grass, Crested Dog's-tail, Golden Oat Grass, Hard Fescue, Sheep's Fescue, and Various-leaved Fescue; sometimes creeping on the surface and very deficient in aftermath — Rough - stalked Meadow Grass; sometimes creeping extensively underground—Smooth-stalked Meadow Grass. Fiorin is a useful grass only on marsh and bog; it grows in various ways—sometimes in tufts, sometimes on the surface, and sometimes creeping underground. Crested Dog's-tail is valuable only for pasture, not for hay. Perennial Rye Grass is most lasting on heavy land. Smooth-stalked Meadow Grass suits deep, light, sandy land, and Creeping Fescue wet, light land. Hard Fescue, Sheep's Fescue, and Various-leaved Fescue suit very light, thin land. Golden Oat Grass suits light calcareous land.

The leguminous plants have sometimes deep taproots, *e.g.* Alsike Clover and Red Clover, whereas True Cow Grass (*Trifolium medium*), which is never sown, is an underground creeping perennial with fibrous roots. Trefoil is a straggling annual with a taproot, and is suitable only for short leys on light land. White Clover is a surface creeper with shallow fibrous roots suitable for soils with surface moisture.

Bird's-foot Trefoil suits deep light land; it has a very deep taproot and its shoots form a tuft, whereas Marsh Bird's-foot Trefoil is an underground creeper suitable for wet marshy land. Kidney Vetch suits deep calcareous sands; it has a deep taproot and a tuft of leafy shoots.

The miscellaneous plants have either deep taproots—Chicory and Burnet, or they creep extensively underground—Yarrow. Chicory has a rosette of ground leaves like Dandelion, and suits deep chalky soils of a moist type. Burnet suits deep, dry, chalky soils.

Seeding of Pastures

The first point to attend to is the best plants to use. Those only should be sown which are suitable for the land, and which experience has shown to be good. If, for example, Crested Dog's-tail and White Clover are natural to the land, these should assuredly be represented in the seed mixture used. The next thing is to attend to the proportion of land to be allotted to each component of the mixture, for on this depends the number of pounds of seed. If, for example, one-tenth of the acre is to be covered with Cocksfoot, we know at once that 2·8 lb. of germinating Cocksfoot seed is about the right amount, since 28 lb. are required for a whole acre. In purchasing the seeds, it is important that they are secured unmixed, and that they are guaranteed as to purity and germinating power. If the seed of Cocksfoot which we purchase contains only 75 per cent of pure germinating seed, we must sow not 2·8 lb. to cover one-tenth of an acre, but 3·7 lb. to allow for the imperfection of the seed used. If, on the other hand, we rely on the seedseller and purchase unguaranteed seed, we are evidently working in the dark, and cannot know so well what we are doing. It is specially important to consider to what extent Rye Grass, both Perennial and Italian, should be used. In arriving at a decision, we should consider that Perennial Rye Grass is, after all, only a small sole grass of very limited duration, useful at first as a hay producer, and afterwards of little utility. If we agree to this, then we should restrict the amount of its seed within much narrower limits than is often the case. If the Perennial Rye Grass has to be seeded, we should consider whether it would be better to grow the Rye Grass for this purpose by itself, or to sacrifice more or less the value of the pasture in succeeding years. Above all, it must not be forgotten that experience has proved that a full crop of hay may be obtained, even though the amount of Perennial Rye Grass seed used per acre is reduced to 15 lb. per acre. In dealing with Italian Rye Grass, it is to be remembered that, though a fast grower and an excellent hay yielder, it is of extremely short duration, and that when it dies out, the weeds natural to the land will take its place. Besides, Italian is very unfavourable to the growth of Red Clover, and so, if we desire useful clean pasture, with much Red Clover in the first year or two, the Italian seeds should be poorly represented in the seed mixture. We now give two examples of ready-made mixtures. Mixture No. 1 is cheap and inferior to No. 2, which is more expensive.

MIXTURE 1 (Inferior Mixture)

Species used.	Percentage of Ground for each Component.	Weight per Acre of Germinating Seed for each Component.
		lb.
Red Clover	10	2·3
Alsike Clover ...	10	1·4
White Clover ...	10	1·2
Italian	10	4·8
Timothy	10	2·1
Meadow Fescue ...	15	8·4
Cocksfoot	10	2·8
Perennial Rye Grass	25	15

MIXTURE 2 (Normal Mixture)

Species used.	Percentage of Ground for each Component.	Weight per Acre of Germinating Seed for each Component.
		lb.
Red Clover	10	2·3
Alsike Clover ...	10	1·4
White Clover ...	10	1·2
Italian	10	5·6
Timothy	10	2·1
Meadow Fescue ...	10	5·6
Tall Fescue	10	5·6
Cocksfoot	10	2·8
French Rye Grass ...	10	5·1
Perennial Rye Grass	10	6

When making up seed mixtures it is useful to have at hand a table showing the number of pounds of pure germinating seed required per acre. This table we now give, taking as our guide the numbers given by Stebler in his Best Forage Plants.

	lb. per acre.
Perennial Rye Grass	54
Italian Rye Grass	49
Cocksfoot.	28
Meadow Fescue	56
Tall Oat Grass or French Rye Grass ...	52
Golden Oat Grass	7
Timothy	21
Meadow Foxtail...	12
Fiorin	11
Reed Canary Grass	18
Smooth-stalked Meadow Grass ...	13
Rough-stalked Meadow Grass ...	13
Alsike Clover	14
Sheep's Fescue	19
Various-leaved Fescue	30
Creeping or Red Fescue	20
Crested Dog's-tail	21
Red Clover	23
White Clover	12
Kidney Vetch	23
Yellow Trefoil	23
Bird's-foot Trefoil	7

[A. N. M'A.]

Formation of Pastures

Grass and clover seeds for temporary or permanent pasture or meadow are generally sown in two ways, viz.:

1. Along with corn, or as it is sometimes expressed, 'with a white crop'.

2. Along with rape, often expressed as sown 'without a crop'.

1. The grass and clover seeds are sown with either wheat, barley, or oats any time from the beginning to the middle of May. In the case of autumn-sown wheat the 'small' seeds are sown, of course, in the following spring, by which time the wheat is several inches in height. In the case of oats and barley the seeds are sown shortly after these cereals have been sown. Some recommend the sowing of the 'small' seeds two or three days after the oats and barley, whilst others prefer to wait until the oats and barley are well above ground. By the former method the 'small' seeds have a better chance of establishing themselves, but this often means a too luxuriant growth of grass and clover at harvest time, and consequent difficulty in getting the corn crop in fit condition for carting. Although the wheat is several inches in height at the time that the 'small' seeds are sown, it is a crop which as a rule does not grow so thick as oats or barley, and in consequence the grass and clover seeds are not retarded.

In preparing the land for the small seeds, the aim of all cultural operations is to obtain a fine seedbed, or such a tilth as will ensure that the seeds are covered with a sufficiency of fine soil as will encourage germination and the early rooting of the different plants included in the mixture. The smallness of the seeds, and, in consequence, of the young plants which grow therefrom, makes it imperative that the seeds be *covered*. Seeds left exposed to sun and wind will not germinate.

As grass and clover seeds are generally sown with either oats or barley after a root crop, part of which has been eaten on the land by sheep, it is often a difficult matter to obtain the desired tilth. The heading of the land by sheep during winter and early spring often means a leathery plough furrow which the harrows only convert into clods that are difficult to reduce by rolling. If dry weather persists in spring, the roller merely leaves a level surface of hard clods, between which the seeds, especially those of the clovers, fall, often to too great a depth. Under such condition the very light seeds of Meadow Foxtail are difficult to cover, and if the method of sowing is that of broadcasting it is doubtful if ever these get properly covered. A deal of the non-success in ordinary field culture with a valuable plant like Meadow Foxtail is due to the above fact. On small plots where it is possible to cover the seed of Meadow Foxtail with a fine covering of soil, excellent results are obtained.

The cultural operations preparatory to sowing will depend to a certain extent upon the way in which the seeds are to be sown. There are two methods of sowing—

(*a*) Broadcasting, either by hand, ordinary broadcast-sowing machines, or by seed barrow.

(*b*) Drilling by coulter drill or by a Cambridge or ring roller, which carries a seedbox at the back from which the seed is delivered into the grooves made in the land by the roller. This latter method, though called drilling, is not so, strictly speaking, but it pretty well attains the same object as a drill, and has the advantage that there are no coulters to disturb the corn, which may be above-ground when the 'small' seeds are sown.

(*a*) *Broadcasting.*—The preparation of the land will consist of a series of harrowings, and the number of times that the land will require to be harrowed will of course depend upon the mellowness of the land. If the land has been mellowed by frost subsequent to its being ploughed, then probably three harrowings will suffice. On the other hand, it may be necessary to roll as well as harrow. The land in any case is left harrowed before the grass and clover seeds are sown. After the seeds are broadcasted the land is harrowed by a special set of short-toothed harrows—teeth about 2 in. long. This operation is depended upon to cover the seeds, and is generally found to be a fairly efficient means of attaining the object. But there is a chance that a portion of the seeds will remain on the surface, and this would not be the case were the seeds sown by a drill.

(*b*) *Drilling.*—This method is now employed to a limited extent only. By means of a proper drill the seed is deposited at a depth of about 1 in. and in rows about 2½ in. apart. Even if the corn has appeared above the ground, little damage is suffered by the disturbance due to the coulters. Sowing by means of a Cambridge roller attains practically the same object as a drill. The seed is deposited into the shallow grooves made by the roller, and the roller is immediately followed by a light pair of harrows which level the surface, and in doing so the seed is covered to a uniform depth. A single harrowing with a light set of harrows would follow the coulter drill, just as in the case of broadcasting or in sowing with the Cambridge roller; but whichever method of sowing is adopted, a final rolling should be given. This last operation leaves the land firm—a desirable condition for grass and clover seeds, and also for the corn, the roots of which, if late sowing is preferred, will have been disturbed by the implements used.

2. When grass and clover seeds are sown with rape, the rape is eaten off generally by sheep during the following autumn. The rape and clover seeds are sown together, the method of sowing being generally that of broadcasting. The cultural operations are similar to those already mentioned under (*a*); but where the land is of light texture or mossy after having been harrowed it should be heavily rolled. The seeds are then broadcasted and lightly harrowed—preferably on mossy land by means of a bush harrow, which can be made by fixing thorn bushes to a wooden beam. The land should then be rolled. The usual time at which the rape and clover seeds are sown is between the beginning and middle of May, but in the warmer districts of Britain sowing is often postponed until June. In the latter case it is then possible to give repeated harrowings to the land, and by this means repeated growths of weed seeds are destroyed.

It is desirable when grass and clover seeds are broadcasted to divide the seed into equal portions, one portion being sown along one direction of the field, and the second portion across. This secures even distribution of the seed—an important matter, especially if the weather be at all windy. [R. S. S.]

Management of Pastures

Where the herbage of a pasture consists of the better grasses accompanied by leguminous plants, little difficulty is experienced in managing the pasture. It is recognized, however, especially if the pasture is being grazed by young stock, that in order to maintain fertility phosphates, and probably potash, should be restored; though restoration of potash, except on the lighter classes of soils, is not by any means so necessary as the restoration of phosphates. Whilst nitrogen is also removed by the grazing stock, the maintenance of the leguminous portion of the herbage goes a great way to compensate for the loss of this element.

In conjunction with any improvement that follows the application of lime or phosphatic manures it is important that the pasture should be well grazed. The benefit in the following summer that arises from the eating off by bullocks during winter of the rough grass left on a pasture, especially after a wet and growing season, is well known. In a 'dropping year' the risk of damage to the herbage in a pasture from a superabundance of grass can be met by removing all the stock from a field for a few days during summer and then mowing the grass. If the stock can be kept out of the field for a few weeks after mowing, the grass makes a fresh growth, and a valuable 'fog' or aftermath will be obtained.

In the case of temporary pastures special treatment is not so necessary, unless it is intended to graze the land for three or more years. If dung can be spared, an application of about 6 tons to the acre at the end of the second season will make it possible for the land to carry a greater head of stock in the following year; and if it is necessary to plough the land after the third season's grazing, a better crop of corn will be procured through the greater root development that follows the application of dung, and from the unexhausted portion of the dung. In any case, whether the land is intended to be down for grass for only one or for more years after the application, well-rotted dung should be used, as there is then less chance of introducing weed seeds on to the land.

Where it is not possible to give dung, then an application of a mixture of 5 cwt. slag and 3 cwt. kainit per acre may be substituted. It is not as a rule desirable to include a nitrogenous manure in the mixture, as at the end of the second grazing season it is generally found necessary to encourage the leguminous plants. The grass components, if a proper seed mixture has been sown, will usually be sufficiently strong, and any application of nitrogen would have the tendency to encourage the grasses to the detriment of the clovers.

In the management of pastures it is essential that attention be paid to the drainage of the land, as otherwise full benefit will not be derived from applications of manures or lime. [R. S. S.]

Pea.—The pea is an annual with round weak stems, which trail on the ground unless supported by other plants or branches of shrubs. The leaves are pinnate, with one to three pairs of glaucous ovate leaflets, and ending in tendrils which wind round small branches and other supports and assist the plant to climb.

The flowers are of the usual papilionaceous type, with white, rose, or purple flowers. They grow singly or two or three together, in short racemes in the axils of the leaves.

The flowers are self-fertile, plenty of seeds being produced by most varieties even when the visits of insects are prevented. The fruit is a legume with two valves, the inner lining membrane of which is tough and leathery, except in the case of a few garden varieties—the so-called sugar peas. The latter have fleshy pods like those of the Kidney Bean. They are boiled in a green state with the seeds in them, and utilized as a vegetable.

Two species of peas are usually recognized, viz.:—

1. The Field Pea (*Pisum arvense*, L.).
2. The Garden Pea (*Pisum sativum*, L.).

The Field Pea is found wild in Italy. It is a comparatively dwarf plant with lavender-purple standard and rose-purple wing petals. The seeds are generally dun-coloured or greyish, some varieties having dark purplish-brown specks upon them.

The Garden Pea differs from the Field Pea in being less hardy, and in having white flowers and yellow or green self-coloured seeds.

A large number of varieties are known, differing in the height of the haulm, speed of growth, and time of ripening. The 'marrow-fat' types have wrinkled, sweetish seeds. [J. P.]

The acreage of this crop is roughly 165,000 in Great Britain, of which over one-half occurs in the east and east midland counties. There are two types grown, namely, the Field Pea, which has a purple flower, and the Garden Pea, which has a white flower. The Field Pea is chiefly grown and used for feeding stock, but in certain districts the garden peas are grown in the fields for pulling for human consumption. The chief varieties of the Field Pea are Common Grey, the Warwick Grey, the Hastings Grey, the Partridge, the Maple, and the Early Dun.

The Warwick Grey is the earliest variety, a rapid grower, yields fairly well, and is better suited to the more northern districts. The Common Grey is the variety most generally grown; it gives the largest yield under normal conditions. The Maple and the Partridge are very similar, being both largely grown, the former being somewhat larger; the peas are somewhat small and round, and of a dun colour.

A typical soil is a light calcareous loam, but peas will grow well on sand or gravel provided there is a certain amount of lime present. On stiff clays and peats they are not a success. Being a leguminous crop they are usually taken in place of clover in the typical rotation, but

occasionally instead of a fallow crop. The application of farmyard manure is not advisable, as it will cause the crop to become very luxuriant in the haulm, and at the same time the flowers will be less likely to set. The same result, and to a greater degree, will be seen if nitrogenous manures are applied; a dressing of a phosphatic manure, either superphosphate or a phosphatic guano, 3 to 4 cwt. per acre, produces good results. On sandy or gravelly soils a quick-acting potassic manure has a very beneficial effect when applied in addition to the phosphatic dressing. The land should be clean and well worked before sowing, which is done in the latter end of February and the beginning of March. The seed is drilled in rows about 1 ft. apart about 2 in. deep, using 3 bus. per acre. If old seed is used the better plan is to steep it in water a day or so before drilling, so that it may germinate sooner. The crop should be hoed, both horse and hand, two or three times until the stems cover the ground and prevent the work from proceeding. The crop will be ready for harvesting some six or eight weeks after flowering, and it should be cut when the lowest pods are ripe, that is when they are changing in colour from green to brown. The cutting is done either with a 'fagging' hook or a special pea hook. The crop is cut into 'wads' or bundles, which are turned over and left lying on the ground. These wads are turned as required some three or four times until they are dry, when they are put into small cocks and then carted, usually about a week after cutting if the weather is favourable. The crop must be handled carefully, especially in hot and showery weather, for not only is the straw liable to break and the pods fall to the ground, but the pods themselves are liable to shell open, with the loss of the seed. It is advisable to thrash as soon as possible after stacking.

A fair average yield will be from 32 to 36 bus. per acre, weighing 65 lb. per bus., with from 1 to 1½ ton of straw.

The chief enemies are similar to those which attack beans, namely the weevil and the aphis. When the latter attacks the crop there is practically no chance of saving it, so the better plan is either to feed it off or plough in as a green manuring.

In certain districts garden varieties of peas are sown in the field for picking green for marketing. This can only be carried out when the soil is easy working and well drained, where the climate is mild, with a very small likelihood of severe late frosts. The land is usually ploughed and well worked after harvest, the peas of the marrow-fat type sown in October or early November. The crop is hoed in the spring, and then sold to the merchants as a standing crop in the early part of May. The buyer has to do the gathering, and covenants to leave the field at a fixed day early in July. The grower can then leave what is left to ripen for seed, or he can plough in the haulm and grow some late turnips or similar crop. [E. D.]

Pea, Garden.—The Garden Pea is an annual with slender, hollow stems and soft green pinnate leaves, terminating in tendrils which enable the plant to climb. It varies in length from less than 1 ft. to over 6 ft. The flowers are white, usually in pairs. The pods vary considerably in size, and the seeds, which are wrinkled in some varieties, smooth in others, are cream-white or light-green when ripe.

The breeding of peas has been practised with conspicuous success by British gardeners, of whom Messrs. T. Laxton, Culverwell, and Eckford deserve special mention. There are now races of peas known as round-seeded, wrinkled, edible podded, or sugar peas. These again are divided into white and green seeded, and tall and dwarf varieties. They come fairly true to character from seeds, but there is little doubt that many of the old sorts are renamed and sent out as new.

Pisum sativum: tall variety

The cultivation of peas is not difficult, as they thrive in a variety of soils, preferring those in the composition of which a certain amount of lime is present. In gardens where lime is absent from the soil, some should be added if peas are to succeed in it. The soil should be deeply cultivated, and of course well drained. It is the

general practice to sow peas in soil that has been manured for a previous crop, such as celery, bearing in mind always that the pea is a gross feeder. Farmyard manure rich in horse dung is best for them, and in summer it is always worth while, even where the soil is rich, to mulch the pea rows with well-rotted stable manure. Artificial manures that are known to be suitable for peas are superphosphates, potash, and nitrate of soda; these, however, should be used in combination with farmyard manure. The effect of nitrate is to improve the flavour and colour of the peas. Generally, however, cultivators rely upon a liberal application of farmyard manure, the deep working of the soil, and a constant supply of moisture at the roots, for the production of good crops of peas. Some growers sow the seeds in trenches made as if for celery, applying a topdressing of soil and manure when the haulms are about half grown, and watering liberally in dry weather. This treatment is certainly advantageous for main crop and late peas. The seeds are as a rule sown much thicker than is advisable. Careful cultivators who aim at first-class produce set the seeds 9 in. or 1 ft. apart in the rows, and

Pisum sativum: dwarf variety

18 in. between the rows, and the difference between peas thus treated and those sown in the ordinary way is most marked. The usual plan is to make the sets of rows 6 ft. apart, except in the case of the dwarf sorts, which may be sown 18 in. apart. The tall-growing kinds, such as Duke of Albany, Ne Plus Ultra, British Queen, and Telephone, require plenty of space, and when the haulms are about 4 ft. high they should be topped. The staking of peas ought to be done soon after the plants have pushed through the soil.

There is a marked variation in the behaviour of peas with respect to time of ripening, some, known as first earlies, being those that do best when sown early in the year so as to have peas ready for gathering early in June. The seeds of these are sown on a warm sheltered border either in November or in January. French market gardeners sow the seeds in frames in November, transplanting the seedlings into other frames as soon as they are strong enough to be removed. They are protected during frosty weather, and exposed to open air and light on every favourable day for at least an hour or so. Only dwarf peas are treated in this way.

Main crop and late peas are sown in the open ground in March, April, and May, the best sorts being the wrinkled marrows. Very late peas are sown in pots in July in a cool place, where they are grown until they show flower, when they are planted in a sunny situation and supplied with water in dry weather. A selection from the many named varieties known would include the following: First early, dwarf—Chelsea Gem, height 1 ft., a heavy cropper; Green Gem, height 18 in.; Harbinger, height 1 ft., peas sweet flavoured; Little Marvel, height 2 ft., a great cropper, producing large pods containing six to eight wrinkled, sweet peas; Gradus, height 2 ft., pods usually single, but containing about eight large, extra sweet peas; English Wonder, an old but excellent pea, 18 in. high, always cropping well, and of good flavour.

First early, tall—Acme; Alderman, a heavy cropper, producing large pods well filled with wrinkled seeds; Centenary, a heavy cropper, large-podded, full, and of good flavour; Early Marrow-fat, a good cropper; Edwin Becket, pods in pairs, averaging nine very large, sweet peas, a heavy cropper; Telephone, pods in pairs, averaging eight large peas of good flavour, a heavy cropper.

Main crop and late—Autocrat, a well-known favourite, and one of the finest of all late peas; British Queen; Continuity; Duke of Albany; Dwarf Defiance, a first-class late dwarf kind; Edward VII; Late Queen, a heavy cropper and a splendid late variety; Magnum Bonum, a marrow-fat, and one of the best of them; Michaelmas, pods in pairs, each containing about eight large peas of good flavour, a fine variety; Ne Plus Ultra, one of the oldest, and still one of the very best peas grown; Royal Standard, a heavy cropper of sturdy constitution; Veitch's Perfection, a heavy cropper and a grand old pea. [W. W.]

Pea.—Parasitic Fungi.—POWDERY MILDEW.—Plants affected with this disease, caused by species of *Erysiphe*, become coated with a white powdery mildew consisting of fungus filaments clinging to the outer surface of leaves and pods, and bearing chains of spores. At a later stage the mildewed patches become studded with minute black dots, the winter fruits. This disease occurs generally in a dry summer, or fairly late in the growing season, and checks the growth of the pods.

DOWNY MILDEW.—This is distinguished by the foliage and pods becoming brown and decaying soon after being attacked, whereas with Powdery Mildew these generally remain more or less green. The fungus filaments live inside the tissues of the plant, and give off the branched spore-bearing organs of *Peronospora*.

PEA SPOT (*Ascochyta pisi*).—Yellowish spots with a brown margin are formed on the pods and foliage, the plant being stunted; sporules are given off from the spots and rapidly infect fresh plants.

RUST.—Yellow uredospores and teleutospores are formed on the Pea, while the æcidia of this rust fungus (*Uromyces pisi*) are found on species of Spurge (*Euphorbia*), causing a curious distorted growth.

Treatment.—Powdery Mildew is checked by

dusting with sulphur. Spray fluids (see FUNGICIDES) are also effective; but some soft soap should be added, and care taken to spray the plants thoroughly. The straw of a diseased crop will harbour all the above fungi, hence it should be raked together and burned.

[W. G. S.]

Pea, Everlasting, a perennial legume, which has been recommended as a fodder crop. See LATHYRUS.

Pea, Insect Enemies of.—The chief enemies of the pea crop are: *Sitones lineata* and *Sitones crinitus* (Pea Weevils), *Bruchus pisi* and *B. rufimanus* (Seed Beetles), *Phytomyza pisi* (Pea-leaf Miner), *Thrips pisivora* (Pea Thrips), *Cecidomyia pisi* (Pea Midge), *Grapholitha pisana* (Pea Maggot), various aphides.

Pea, Leaf Blotch. See PEA—PARASITIC FUNGI.

Pea and Pea Products.—The pea plant (*Pisum sativum*) is highly valued for both its seeds and its haulms or straw, these being much more nitrogenous in character than the corresponding cereal products.

Peas are grown both as field and garden crops in very numerous varieties, chiefly for the seed, which is a valued food for both man and beast. The composition of individual samples is subject to great variations, but in the main is much as follows:—

	Composition	Digestibility (Cattle or Sheep).
	per cent.	per cent.
Moisture	14	—
Albuminoids	22½	86
Oil	1½	65
Crude fibre	5½	70
Ash	3	—
Soluble carbohydrates, &c. (by difference)	53½	93
	100	

The data for digestibility given above for the case of ruminants probably require little, if any, alteration for the case of horses or pigs. It will be noted that peas are digested, if anything, more thoroughly than the cereal grains, but against this must be set the fact that the latter are digested rather more rapidly.

As in the case of other seeds, the composition is considerably affected by the relative proportions of seedcoat to kernel. It would appear that on the average the seedcoat forms about 7½ per cent of the total weight of the seed. The seedcoat, as in the case of cereal husks, is rich in crude fibre, probably of low digestibility, and generally of low nutritive value. Dietrich and König give the following average composition for pea shells:—

	per cent.
Moisture	12·04
Albuminoids	7·26
Oil	1·21
Crude fibre	44·74
Ash	2·89
Soluble carbohydrates, &c. (by difference)	31·86
	100·00

Owing, then, to the greater proportion of seedcoat, small peas should in general be less nutritious, weight for weight, than large peas of the same variety grown under similar conditions.

From the data for composition given above, it will be noted that the pea is characterized by its richness in albuminoids (albuminoid ratio 1 : 3) and its relatively high digestibility, and it is from these facts that the value attached to peas for feeding purposes largely arises. The albuminoids comprise several ingredients, the chief of which is the well-known globulin, legumin. The 'oil' (ether extract), as in the case of many other leguminous seeds, is characterized by the presence of a very considerable proportion (up to 40 per cent) of the phosphatic fat-like substance, lecithin. Of the carbohydrates the most abundant is starch, but it is accompanied by considerable quantities of cellulose, the cellulose-like galactans, and small quantities of sugar. The ash is rather more abundant than in the case of most cereal grains, and is characterized by its relative richness in potash and phosphoric acid. The average proportions of the chief ash ingredients of peas are given by Wolff as follows:—

Potash (K_2O).	Lime (CaO)	Magnesia (MgO).	Phosphoric Acid (P_2O_5)
per cent.	per cent.	per cent	per cent.
43·1	4·8	8·0	35·9

These proportions of potash and phosphoric acid, along with, say, 3·6 per cent of nitrogen also present in the peas, will correspond to a manurial value (Hall and Voelcker) for compensation purposes of about 28*s.* per ton of peas consumed during the closing year of tenancy.

Owing to their richness in digestible, highly nitrogenous material, peas, like beans and other leguminous seeds, are particularly useful whenever it is desired, by enriching the rations in albuminoids, to obtain a more intensive and rapid production of either muscular energy, milk, flesh, or fat. They are hence found specially valuable as an ingredient of the food of hard-worked horses, of fattening or milk-producing animals, and also of growing animals of weakly constitution. A certain degree of caution is necessary in their use, however, especially with horses, owing to their property of swelling up when moistened with water, and the richness of the shells in astringent matter (tannins), whereby flatulence, colic, or more serious disturbance in the alimentary tract may be caused. There is, moreover, further possibility of danger in the formation of intestinal concretions owing to the richness of the ash in phosphates of potash and magnesia. The risks are only great, however, when large quantities of dry peas (or meal) are fed, and indeed, when reasonably applied, the qualities above referred to may be made to render useful service. Thus the astringent property renders peas a useful food for the rapid restoration of the condition of animals that have suffered from looseness, whilst the richness of peas in phosphoric acid may be made very valuable for bone formation in the case of growing animals when peas are suitably blended with foods containing an excess of lime. When the shells are fed along with the kernels, care must be taken to ensure thorough mastication,

since the shells, especially if old and dried, are very tough. Soft water is to be preferred to hard water for soaking peas, since the lime in hard water has a tendency to unite with some of the albuminoids, forming difficultly digestible compounds. This action may be largely prevented, however, by the addition of a small quantity (say 2 oz. per cwt. of peas) of carbonate of soda to the hard water.

To horses peas are commonly fed whole or roughly crushed (split peas), but to cattle and pigs in the form of meals. When fed to horses the quantity must be somewhat limited, and as a rule it will be inadvisable to give peas to an extent greater than, at most, one-half of the total grain ration; one-third will probably be more suitable, or, for light work, even less. When fed to fattening animals, especially pigs, pea meal is usually found to have a favourable influence upon the quality of the carcass, a well-grained, fine flavoured flesh, and firm fat, being produced.

Pea meal is also widely favoured for dairy cows, but if given in large amounts is liable to give a hard consistency to the butter fat, and may be detrimental in other ways.

Peas have further been used with success in fattening geese and turkeys. According to Pott, a fine white tender flesh is obtained by feeding peas thoroughly soaked in buttermilk.

Considerable quantities of peas are ground up for the production of pea meals, pea flours, &c., the finer qualities of which are used for human consumption in various forms. In the preparation of these finer meals the pea shells are removed and often added to the coarser meals which are sold for agricultural feeding purposes. These latter meals are, moreover, frequently adulterated with bean-, maize-, and other meals. Their composition is thus extremely variable. A good sample should not differ appreciably in composition from whole peas. Any considerable addition of ground pea shells will, of course, involve a decidedly high proportion of crude fibre in the meal and may thereby be detected. Where peas are used in large quantities, however, it is advisable to buy them whole and grind as required, since the possibility of adulteration is then largely removed. A word of warning may be given as to the frequent occurrence in imported peas of the angular pealike seeds of *Lathyrus sativa*, since these have been found to be objectionable, especially for horses.

PEA STRAW, when harvested in sound condition, is the most nutritious of the straw fodders, being equally nitrogenous with bean straw, and less coarse in texture. The average may be taken to be somewhat as follows:—

	Composition. per cent.		Digestibility (by Sheep). per cent.
Moisture	14	......	—
Albuminoids (crude)... ...	9	......	60
Oil	1½	. ...	46
Crude fibre	35	......	52
Ash	6½	......	—
Soluble carbohydrates, &c. (by difference)	34	......	64

Pea straw is thus appreciably richer in albuminoids, poorer in crude fibre, and more digestible than the cereal straws. It approximates closely, indeed, to good meadow hay, or at its best, even to clover hay. Like bean straw, however, it is not very palatable, is very susceptible to fungoid attacks, and rather difficult to harvest in good condition. For these reasons, and owing to the usually limited supplies, it is commonly only fed in admixture with other fodders and roots. It is found to be particularly suitable, when chaffed or steamed, for dairy cows and ewes. [C. C.]

Peach (*Prunus persica*), a widely distributed tree which has been cultivated for its fruits from the remotest antiquity. Except in the form and colour of the fruits there is very little variation in the peach, whether wild or cultivated, the most marked variety being the nectarine, which has smooth instead of hairy fruits. It is remarkable that the varieties in many instances are reproduced from seeds. In America peach trees are largely multiplied from seeds, and this may be accepted as proof that very little change has been wrought in the peach by centuries of cultivation. In the warm parts of Europe, Asia, Africa, and America the peach is extensively grown. In temperate regions it can only be cultivated in sheltered situations, where protection can be afforded in cold weather; and to ensure its safety it must be grafted on a hardier species, the plum, to which the peach is closely related, being generally used as a stock in this country. Under ordinary conditions the peach takes five months from the time of flowering to mature its fruits. In the British Islands generally, peaches are grown either against a wall or under glass, the most favourable situation being a deep border of rich loamy soil against a wall facing south. Good drainage is essential, and at no time of the year, winter or summer, should the soil be allowed to become dry. It is therefore necessary, if the good cultivation of peaches is intended, to provide these conditions; and in many gardens this means the removal of all the soil in the border to a depth of at least 3 ft., replacing it with good meadow loam, with which limestone or mortar rubbish should be mixed, lime being essential to the formation of the fruit stone. If manure is used it should be incorporated with the soil just below the surface, and afterwards, when the trees are established and large, manure should be forked into the border annually. The trees should be planted 6 in. from the wall and 20 ft. apart, the best time for planting being in autumn as soon as the leaves have fallen. After the trees are planted, a mulch of stable manure should be spread over the soil.

Peaches should be pruned not later than the middle of February, just before the flowers open. As the flowers are developed on shoots made during the previous season, pruning at this time should be limited chiefly to the removal of superfluous shoots. The tree must have a number of principal branches to constitute its framework, and the pruner must always bear this in mind. After the tree has been formed, pruning is

shortening the flowering shoot at the winter pruning; (2) training succession shoots in summer; (3) the removal of the shoots that have borne fruits, except such of them as are leading shoots of branches. The distance along the branches from one bearing shoot to another should be about 12 in. In summer much may be done in the way of regulating the shoots by stopping, *i.e.* pinching out the growing points.

Whilst the plants are in flower they require to be protected from cold winds and frosts. This is done either by hanging nets in front of them, or placing lights or boards against the wall so as to form a temporary greenhouse. They sometimes set many more fruits than it is desirable that they should mature, and thinning must then be resorted to. The varieties recommended for open-air culture are: Alexander, Early Louise, Hales' Early, Rivers' Early York, Crimson Galande, Dymond, Stirling Castle, Alexandra Noblesse, Bellegarde, Princess of Wales, Sea Eagle, and Late Admirable. [W. W.]

Peach.—Parasitic Fungi.

LEAF-CURL.—This common and destructive disease, recognized by the leaves becoming puckered or blistered, appears soon after the leaves unfold, the diseased parts generally turn yellow or red, and the leaves fall prematurely, bearing with them numerous spore-cases of a fungus (*Exoascus deformans*), which cover the blisters with a whitish coating. During the winter the fungus filaments live in twigs and branches, hence the disease is difficult to combat, except by hard pruning of all twigs which have borne diseased leaves.

MILDEW (*Sphærotheca*).—This is frequent under glass, causing a mealy mould on foliage and young fruit. As the fruit ripens, the mildewed spots become brown and cracked. Applications of sulphur check this disease.

LEAF SPOT.—Several fungi are recorded in cases where the leaves were spotted or perforated with holes, but this condition may equally well result from insects, from spray fluids used too strong, or from drops of water on the leaf.

FRUIT ROT.—The frequent occurrence of soft brownish spots on the fruit may be due either to *Monilia* or to *Glœosporium fructigenum*, two fungi injurious to all kinds of orchard fruit (see APPLE—PARASITIC FUNGI). Cracked fruit resulting from a dry skin may be due to the mildew already mentioned, or to the peach scab fungus (*Cladosporium carpophilum*).

GUMMOSIS. See art. GUMMOSIS.

Silver leaf and peach yellows are troublesome diseases, but it is doubtful whether they are due to fungi. Chlorosis or yellow leaf occurs on soils deficient in iron.

Treatment.—As peach foliage is easily damaged by fungicides, care must be taken in using them. The following are some remedies of experienced growers: Bordeaux mixture is generally used for outdoor trees; the first spraying is done with medium-strength Bordeaux before the buds swell; later sprayings on the foliage must be done with the weak-strength mixture. For leaf-curl, potassium sulphide (½ oz. in each gallon water) is sprayed on diseased foliage, and continued twice a week till healthy growth begins. Sulphur applied by means of a vaporizer several times in autumn, and fortnightly after flowering, is another grower's cure for leaf spot and mildew. Pruning and burning diseased twigs will check leaf-curl, and is the only remedy for gummosis. The injurious effects of a cold sunless spring are well known; but in indoor cultivation care as regards ventilation, heating, and syringing, so that water does not remain too long on the foliage, will do much to check the spread of parasitic fungi. [W. G. S.]

Peach, Insect Enemies of.—The chief insect pests of the peach and nectarine are: *Cheimatobia brumata* (Winter Moth), *Lecanium persicæ* (Peach Scale), *Aphis amygdali* (Peach Aphis), *Myzus cerasi* (Cherry Black Fly), *Tetranychus telarius* (Red Spider). See the descriptions of these insects under their technical designations.

Peacock, a gallinaceous bird of gorgeous plumage whose native haunt is south-eastern Asia, over which it is widely spread. In many parts of the Indian peninsula and in Ceylon it is quite common. In its wild state it frequents the higher trees, choosing the barer branches so that its truly magnificent plumage may be displayed to the fullest advantage. The hen selects a secluded spot on the ground for her nest, the number of eggs which she lays varying from four to ten, and the period of incubation being from twenty-eight to thirty days.

The distinguishing characteristics of the Peacock are the crest or aigrette on the top of the head, and the peculiar structure of the tail-covert feathers. The expanse of tail with its exquisite hues is strictly speaking an excessive development of the tail coverts or side feathers, which spring from the back and grow to a great length, occasionally to 4½ ft. The true tail is hidden underneath and acts as a frame to support the brilliant plumage when elevated.

The Common Peafowl (*Pavo cristatus*) is frequently met with throughout India, Ceylon, and the adjacent islands. The rich, glossy purple of the head, neck, and breast of the male shades harmoniously with the copper-coloured lacings of the back feathers and the rich green of the tail. The female is much more subdued in colour. The crest or aigrette, common to both sexes, is composed of twenty-four feathers, which are only webbed at the tip, where they show blue and green reflections.

The Japanese Peacock (*Pavo muticus*) is larger, and differs in colour and other points from the common bird. The crest on the head is much longer, and the feathers are webbed from the base instead of at the tips only. The golden-green neck and breast form a ready means of identification. It is a native of Burma, Java, and Siam.

The Japanned or Black-winged Peacock (*Pavo nigripennis*) is not known to exist as a wild race. In its dark wings and thighs it differs essentially in colour from the other varieties. Some authorities are inclined to classify this peafowl as a distinct species, but Darwin and others place it as a variety only.

Both white and pied colours are to be met

with occasionally, though they are much less attractive in appearance than the others.

Peacocks do not attain to full maturity till they are three years old, and they live to a good age. Some credit them with a hundred years, though this may be extreme, but fifty is a known age to which they have lived. By the ancients they were regarded as a table delicacy, but, though the flesh is of nice white colour, with fine texture and flavour, it is very rarely seen on a modern menu. [M. P.]

Pea Meal. See PEA AND PEA PRODUCTS.

Pea Nut. See EARTHNUT.

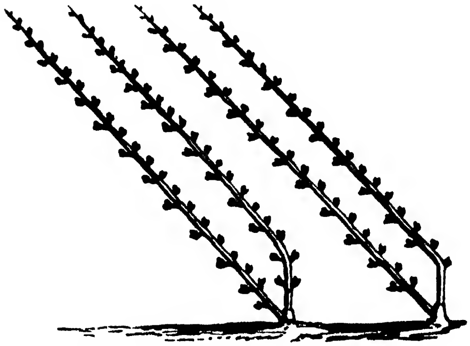


Fig 1.—Pears: Double Oblique Cordons

Pear.—The numerous varieties of garden pears have originated from *Pyrus communis*, which is wild throughout temperate Europe and Western Asia. It occurs wild in England, most frequently in woods and coppice, and probably often as an escape or seedling from a cultivated variety.

In addition to its value as a fruit-producing tree, the pear is one of the most attractive of all trees during its period of flowering in the spring. For this reason it deserves to be planted as an ornamental tree; indeed in many parks and large gardens, groups of pears, apples, plums, and cherries might with advantage take the place of the less ornamental trees which generally find favour with landscape gardeners.

The cultivation of the pear for its fruit is generally identical in essentials with that of the apple; and where the one succeeds, the other is pretty certain to be equally successful, the only difference being that some varieties of pears, owing probably to their French origin, are more tender than others, and therefore require a higher temperature than is to be found in the colder parts of the British Islands, where apples and a few of the hardiest pears may be successfully grown. There is always uncertainty with regard to the behaviour of pears, and it is for this reason wise, before deciding what to plant, to first ascertain what kinds succeed in the district. In England the best pears are grown in Kent and those counties with similar climatic conditions, though it is certain that pears might be cultivated with profit in many parts of the British Islands where they are at present scarcely known. For the development of its finest qualities the pear requires bright sunshine, protection from cold winds, and a good loamy soil. The best pears are undoubtedly produced by trees grown against walls facing south or south-west. All the varieties are multiplied by grafting or budding them on stocks either of seedling pears, known as free stocks, or on the quince, the latter being preferred for dwarf trees which are required to fruit early, whilst for large orchard trees the seedling pear is best as a stock.

Unfortunately, pear stocks are sometimes raised from seeds of cultivated varieties of pears, instead of, as they should be, from seeds of the type, or wild pear. Consequently, failure is sometimes due to faultiness in the stock, although apparently it is of the right kind. For this reason, young trees for planting should be obtained from trustworthy dealers.

It has been said of pears when grafted on seedling pears which are longlived but comparatively slow in arriving at a fruitful age, that 'He who plants pears plants for his heirs'. Trees on quince stocks, however, quickly grow into a bearing condition, and it is therefore advisable to plant in small gardens trees on quince stocks, reserving those on free stock for orchard or field cultivation. When pears are grown against walls they require to be skilfully trained and pruned. There are various methods of training, examples of which are shown in the accompanying figures. The pruning of pears in the open is the same as for apples (which see).

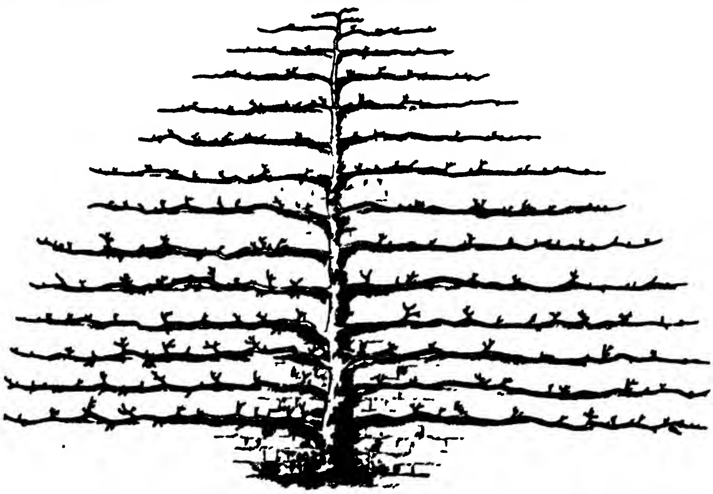


Fig. 2.—Horizontally-trained Pear

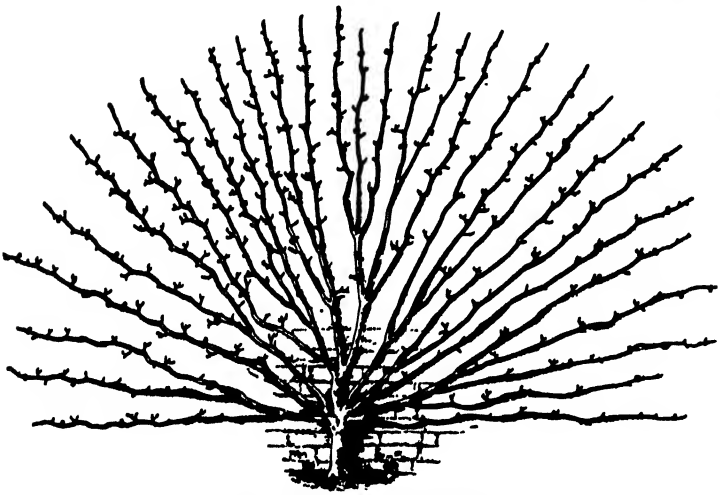


Fig. 3.—Fan-shaped Trained Pear

Duchess, Bergamotte Esperen, Beurré Giffard, Beurré Rance, Gansel's Bergamot, Josephine de Malines, Clapp's Favourite, and Marie Benoist.

Stewing pears: Bellissime d'Hiver, Catillac, Verulam. [W. W.]

Pear.—Parasitic Fungi.—

LEAF AND FRUIT SPOT.—Damaged foliage is common, especially on old trees, and when the leaves fall prematurely the wood is not properly ripened for next season, while the fruits remain stunted and hard, and altogether inferior as market produce. *Scab*, accompanied by the fungus *Fusicladium*, is common on Pear and Apple; it appears as dark velvety patches on leaves and twigs, while the young fruit becomes scabbed, cracked, and frequently deformed. *Leaf Scald* (*Entomosporium maculatum*) covers the foliage with small dry spots, and if these are numerous the leaves drop off; this fungus sometimes extends to the fruit and causes reddish spots, but rarely cracking. *Rust* is easily recognized on the leaves as red blisters bearing clusters of projecting yellow æcidium-cups of *Gymnosporangium* which passes through the other stages of its life-history on Juniper. *Powdery Mildew* forms a whitish mould on the foliage and young fruits. *Leaf Blister* appears as swollen blisters, green at first, then brown, and frosted with spore-cases of an *Exoascus*, a near relative of the peach leaf-curl fungus. *Fruit Rot* forms discoloured spots, which become soft and rotten.

STEM CANKER AND WOOD ROT follow attacks by the canker fungus (*Nectria*), or by species of the *Polyporus* family; for further details, consult the art. APPLE—PARASITIC FUNGI. [W. G. S.]

Pear, Insect Enemies of.—The chief insect pests of the Pear are: *Diplosis pyrivora* (Pear Midge), *Cemiostoma scitella* (Pear-leaf Blister Moth), *Orgyia antiqua* (Vapourer Moth), *Eriophyes pyri* (Pear-leaf Blister Mite), *Schizoneura lanigera* (Woolly Aphis), *Eriocampa limacina* (Pear Slugworm). All these insects and their ravages are described in the various articles under their technical designations.

Pear-leaf Scab. This fungoid disease is treated in the art. PEAR—PARASITIC FUNGI.

Peasant Proprietary.—This term denotes the ownership of agricultural land by the occupying cultivators, but in common speech it is generally employed as synonymous with small occupying owners. Thus while in the United States and Canada the majority of the farms are held by landowning farmers, it would be very unusual to speak of them as peasant proprietary. The term is almost always restricted to small properties on which the farmer performs the work with little or no hired labour. In most

Trees grown against walls have their main branches trained as shown in the several figures herewith, and the lateral growths are kept pruned so as to form what are known as spurs. A spur is a branch the buds of which are either blossom buds or growth buds. They are either simple or compound, as shown in fig. 4. The compound spur requires to be cut as shown. Fig. 5 represents a branch on the shoots of which no fruit buds have developed, and the terminal buds require to be kept in check in order that the sap may be concentrated on those at the base.

Fig. 4.—Spur-pruning

1, Simple spur; 2, compound spur

Fig. 5.—Spur-pruning

Twelve pears suitable for orchards: Belle Julie, Beurré Bosc, Beurré Capiaumont, Beurré Hardy, Durondeau, Emil d'Heyst, Jargonelle, Louise Bonne of Jersey, Marie Louise, Williams' Bon Chrétien, Winter Nelis, Doyenne d'Été.

Twelve pears suitable for walls: Beurré Superfin, Doyenne du Comice, Glou Morceau, Marie Louise, Pitmaston

of the countries of Europe the disappearance of serfdom left a large proportion of the peasantry in the position of small owners; and scarcely anywhere, save in Britain, did they lose all direct interest in the soil. During the last century, too, in most of those countries legislation has fostered small ownership, partly for political and social reasons, preventing the concentration of landed property in the hands of a few, and encouraging the growth of a hardy country population as an invaluable national asset.

In Prussia the establishment of peasant proprietorship was effected by the land reforms of Stein and Hardenberg, when the emancipated serfs obtained complete ownership of the land they cultivated, and were relieved of all dues on condition of surrendering as compensation to the landlords a portion of their holdings or a money equivalent. Other German States copied the system, and now 86 per cent of the cultivated area of the German Empire is in the possession of occupying owners. The French peasant showed an effective desire, long before the Revolution, to own his small parcel of land, for in 1788 about one-third of the agricultural area was owned by its cultivators. The prevalent idea that the system originated in the confiscations of the Revolution is therefore mistaken; but the effect of that event was to give it greater encouragement, partly by the breaking up of confiscated estates and partly by the removal of the former feudal dues and exactions which had pressed heavily upon the peasantry. Now about 53 per cent of the agricultural land of France is cultivated by its owners. In Denmark, legislation in the last twenty years of the 18th century transferred to occupying owners much land which had hitherto been State or communal property, and this process was widened and amplified after the middle of the 19th century by enactments and financial facilities provided by the Government, resulting in the sale of farms from owners to tenants. Consequently, to-day almost all the cultivated area except a few small islands is in the ownership of the peasantry, the holdings varying in size from small allotments to seventy or more acres. The legislature has also taken steps to prevent the future concentration of land in few hands. Other countries, such as Switzerland, have likewise fostered peasant proprietary; and in Ireland the most recent land reforms have the same end in view, so far having unquestionably proved socially beneficial. But Great Britain is a country of large estates and of relatively large farming, and although at one time she possessed a considerable number of small owners and yeomen they have tended to disappear.

Among the merits claimed for peasant proprietorship may be mentioned the encouragement it gives to intensive cultivation. Thus Adam Smith said that 'a small proprietor who knows every part of his little territory is generally of all improvers the most industrious, the most intelligent, and the most successful'. And Arthur Young, who was, like Adam Smith, an opponent of small farming in general, observed: 'Give a man secure possession of a bleak rock and he will turn it into a garden'. There is perfect security for capital invested, for improvements made, as well as absolute freedom of cropping; and these lead to industry and high productivity. There is no fear of the interference of a landlord, or of working for another to reap the fruits. The system fosters thrifty, independent men of stable character, and keeps a large number of families in healthy rural occupations. It further induces hopefulness by affording opportunities for rising to energetic and thrifty labourers, beginning with a very small holding and gradually increasing the area.

Much of this praise is well-deserved and can stand the test of experience in some of the countries above-mentioned; but opponents of the system point to disadvantages, and it was the custom of English writers half a century ago to decry it as uneconomic until J. S. Mill took a leading part in its defence. It is true that it involves relatively small farming in older countries, and so is most effective in those forms of agricultural production where success depends greatly upon detailed work and personal attention. But when account is taken of the trend of recent development, prices and markets, it is seen to have relatively favoured small farming in Western Europe, and it is particularly the countries of peasant properties which are markedly advancing in the production and export of such commodities as milk-products, eggs, poultry, and bacon, while they are no longer backward even in cattle-breeding. There may sometimes be danger of splitting up farms until they are too small to be economic holdings, but this is not in practice found to be serious, and is often rather an effect of laws of inheritance than an essential feature of peasant proprietary. Again, some who acknowledge the tendency of the system to encourage industry and productivity urge that the small owner often cultivates to such a point that the return to his final increments of labour is very low. He will expend further effort on the land for a very slight addition to the gross yield when it would not pay to employ hired labour for such intensive farming, and so the net yield is not increased so much as the gross yield. It used to be said that the system bred parsimoniousness and conservatism, and that even when these were not present the peasant lacked the capital necessary for making improvements and stocking the farm adequately; but these objections have lost most of their force with the spread of education and co-operation, and the small owners in such countries as Denmark are an alert and enterprising race. See also arts. LAND, SMALL HOLDINGS, CROFTER LEGISLATION.

[S. H. T.]

Peat and Peat Products.—Peat may be divided into two kinds—hill peat and lowland peat. Broadly, the former may be said to be composed largely of *Sphagnum* moss and the latter of *Hypnum* moss, but these distinctions are not of so much importance as the variations between the upper and lower layers. The upper portion is usually light and fibrous, of less value for fuel, but suitable for fibre, litter, &c.; while the lower strata become progressively compact, heavy, dark-coloured, and carboniferous, the bottom layer being the heaviest and best for burning, if free from earth or sand. It is stated

that the area occupied by peat in the United Kingdom is about 6,000,000 ac., of which about one-half is in Ireland.

The black heath-mould, which is called bog earth or peat by gardeners, has a different origin. It is a sharp, sandy soil, containing rather over one-third of sand, mixed with dead, fibrous roots of heath, &c., and other vegetable matter, which form about a quarter of the whole. This constitutes the shallow surface soil of many English heaths, and is largely used in horticulture for growing plants requiring a well-drained light medium, especially for rhododendrons, azaleas, &c. Another description of bog earth used in horticulture is composed of dead roots of bracken and other vegetable matter. This contains practically no sand.

Composition of Peat.—The composition of peat varies very considerably, and its value for fuel naturally depends on its heating power, which increases as the proportion of water and ash decreases. Air-dried peat contains on the average 25 per cent of water, in warm districts less, in damp regions more. The Bulletin of the Imperial Institute (1905) states that pure peat, exclusive of moisture, has been found to contain the following percentages: carbon, 49·6 to 63·9; hydrogen, 4·7 to 6·8; oxygen, 28·6 to 44·1; and nitrogen, 0·0 to 2·6. The mean composition of good air-dried peat is approximately: 'hygroscopic' water, 25·0; water, 28·5; hydrogen, 1·5; and carbon, 45·0 per cent. According to some 1000 tests made by Dr. Bersch, the calorific power of the organic substance varied between 4000 and 6800, or for air-dried peat containing 25 per cent water from less than 3000 to 4500 calories.

Several methods of dealing with peat or turf are practised. It may be dug out and treated entirely by manual labour, as is the case in Ireland, where it constitutes the chief fuel of the people; it may be extracted and pressed into blocks by machinery, and enormous quantities of material for burning are thus obtained on the Continent; or it may be manufactured by various processes into litter, fibre, paper, peat dust, and many other materials.

Dug Peat.—If a bog has not been previously worked, a deep cut is first opened leading to an outlet, and the peat is then dug out with a peat spade, which is a long narrow sharp spade, with the edge turned up on one of the long sides, so that it cuts two sides of the sod at once. The block is placed on the side of the bank to drain until it can be handled, and is then taken away on wheelbarrows to the drying ground, which is usually some fairly firm part of the bog. Here the peats are stacked, and after a few days turned and placed on end. This operation may have to be repeated a number of times according to the state of the weather, six weeks being about the shortest time required. The great difficulty is indeed the uncertainty of the climate. Frequently the peat, after being partially dried, is built up into stacks 4 or 5 yd. long, 4 ft. wide at the bottom, narrowing to 1 ft. at the top, the outer turf being sloped so as to throw off the rain. These clamps are fairly satisfactory in average seasons. Drying peat under sheds is open to the objection that the peats in the centre are protected from the wind and take a long time to dry. Another method is to suspend hurdles one over another between four poles, on which the peats are laid. These are covered with a rough roof.

Several machines for cutting the turf have been invented and are in use on the Continent. They are worked by hand, and act by forcing a square frame down into the bog. At the required depth a knife cuts the peat at the bottom of the frame and separates the moss, which is then raised to the surface.

Mud Peat.—The cutting of peat with a spade as above described is the cheapest method which can be adopted, but the bog is frequently so saturated with water that it cannot be cut. It is then dredged out with a scoop or pail, and emptied on a space enclosed by boards, and allowed to drain. It is solidified by treading, and afterwards cut into blocks.

By mixing up the various layers of peat a much better quality of fuel is produced, both as regards burning and heat-giving properties, and this system of making 'mud peat' prevails very largely in Ireland. A farmer buys or hires so many perches of bogland, most of which has to be used as a drying ground, the peat being actually dug from only a small part of it. The work is begun in early summer, May or June, and the first step is to level roughly the drying ground, and then to strip the place where it is intended to dig. When this is done, four men commence to dig and throw out the mud peat, while two men break and mix it with forks, trampling on it and turning it continually, with the object of mixing the poorer peat from the top layers with the heavier peat from the lower layers, and thus producing a mixture of uniform quality. When the mixing is complete the mud is wheeled in barrows and spread over the drying ground to a depth of 9 to 12 in.; the turf is then shaped by hand. With good weather the turf may be turned, or 'footed' as it is called, in about a fortnight, and afterwards re-footed; it may then be put in small 'clamps', and after a further interval carted home. Commonly, however, it may need to be reclamped, and is seldom taken away until September or October. Taking all the charges into account, Mr. A. S. Lough estimates the cost of making good mud turf at 10s. per ton; but as most of this is for labour, the Irish farmer does not appreciate the cost, as the work is mostly done by men helping one another by exchange, and is not paid for in cash.

One of the great difficulties met with in Ireland and elsewhere is that of drying the peat. Air-drying is practically the only means applicable to small quantities in cases such as that of the Irish farmer, who digs the peat required for his own winter fuel. A strong wind is desirable, without much sun, as the latter only hardens the outside of the peat, whereas the wind dries the peat gradually. Where large quantities of peat have to be dealt with, drying by radiation from stoves and furnaces has been tried with some success.

Manufactured Peat.—A very large number

of processes have been patented for manufacturing peat by machinery. One of the oldest was invented by Professor Siemens in 1857. In this the peat was put in vats, where it was soaked and worked with water. It was then passed into a pulping machine, which broke it up into a fine pulp and delivered it into moulds. This is still to some extent the principle of the more modern types of machinery.

In 1903 the Department of Agriculture for Ireland made an experiment with a 2-h.p. plant, but the bog on which it was made was too small and shallow to give satisfactory results. The plant consisted of a cutting machine and of a machine for masticating and shaping the peat into blocks. The former was planted on rails on the edge of the bog, and worked like a pile driver, a heavy three-bladed cutter being raised on a framework 12 ft. high and allowed to drop suddenly into the bog. When raised to the surface again it was full of mud, which was dug out and wheeled to the chopper of the shaping and mixing machine. When the peat was thoroughly mixed it was pressed out through the nozzle of the machine on to boards, being, as it passed out, cut by a lad with a blunt knife into blocks measuring 10 in. by 4 in. These boards were carried to the drying ground, where the blocks were slipped to the ground. Two horses were required to drive the mixing machine, and ten men and boys to work the whole plant. The output was about 14,000 peats per day, or about 6½ tons. Owing to their small size and to the thorough mixing and pressure they received, the peats dried quickly, and showed a great improvement in quality and heating properties compared with hand-made peat. The cost price per ton, paying wages at 2*s.* per man per day, and two horses at 10*s.* per day, amounted to 6*s.* 4*d.*, exclusive of machinery and superintendence, but including all other charges. The use of horse-power to drive the machinery was considered inferior to steam.

A number of more elaborate systems are in use in Sweden, Denmark, and Germany. The Abjörn-Andersson system consists of an elevator which digs the peat from the bog into a macerating machine, in which it is made into a kind of pulp and moulded into bricks, which are removed on a continuous belt. The whole machinery, with a steam engine, is mounted on a trolley, which is moved forward on the bog as necessary. Another method, which is largely used in Russia, is the Anrep system. In this system peat enters through a hopper, and is macerated with knives and screws. It is then forced out through the mouthpiece and cut off in pieces about 13 in. long by 4½ in. wide. 50 or 60 tons of peat per day may be made with a large machine of this type. Another similar Swedish system is that of Akerman. A description of the machinery employed in these various processes will be found in Bjorling and Gissing's Peat: Its Use and Manufacture. According to an estimate by J. G. Thaulow the Akerman machine, with all adjuncts, including 18-h.p. engine, rails, wagon, &c., would cost £390; the machine alone costing £67, and would produce 20 to 25 tons of dry peat per 10 hours with 15 men. A 38-h.p. Anrep machine, with engine and accessories, would cost £830. This would produce 40 to 45 tons of peat per day, but requires 38 men to work it. The Akerman machine has been the longest and most extensively used in Sweden. The total cost of peat manufactured in this way is about 5*s.* 6*d.* per ton, loaded into wagons at the bog.

Peat Briquettes.—Peat in its natural state is very bulky, and is expensive both to store and to transport; the manufacture of compressed peat has, therefore, been resorted to, both in Europe and in Canada. The following description of a system adopted in the latter country is summarized from an account given in the Imperial Institute Bulletin (1905). The peat is first excavated by a machine known as Dobson's Mechanical Excavator, which is worked by a 10-h.p. electric motor. This skims off thin slices of peat, which are thrown on the surface of the bog some distance away, and thence conveyed to the factory when sufficiently dry. It is then passed into the hopper of a disintegrating machine, where it is subject to a fierce hail of blows in order to reduce the size of the fragments and destroy the minute plant cells of the peat fibres. The mixture of fine particles and dust thus produced is taken to the Dobson dryer, which consists of a cylinder 30 ft. long and 3 ft. in diameter, revolving somewhat slowly so that a charge of peat will pass through in 20 minutes. Heat is applied, and air-dried peat containing about 34 per cent moisture leaves the dryer with only 16 per cent. The peat is then pressed into briquettes. The Dobson press consists of a number of dies resting on a solid base which are rotated beneath a ram. The dies being filled with peat powder, the ram compresses it into briquettes, 25 of which weigh 10 lb. The output of the press is 12½ tons in 10 hours. The cost is slightly over 4*s.* 2*d.* per ton, or taking into account cost of the bog, interest on capital, royalty, and depreciation of plant, 7*s.* 6*d.* per ton. Various mixtures have been used in making briquettes, especially coal dust.

Peat Charcoal.—The object of carbonizing peat is to get rid of that portion which has no heating value, and to produce a charcoal which will compete with coal or coke. The common and simple method adopted on the Continent is by charring in heaps in the same way as wood charcoal. A carbonizing furnace has been invented by M. Ziegler of Berlin, in which the gas driven off from the peat itself is used for coking. Both peat and peat charcoal are used for metallurgical purposes.

Peat-moss Litter.—Peat moss has been used from very early times by the peasantry in the neighbourhood of peat bogs, but it was first manufactured commercially in Germany in 1878 by Hollmann. The turf is dried in large stacks in the open air, and when dry removed to a factory. Here it is torn into small particles by a 'wolf' machine. The fragments are then passed over sieves to separate the dust (called peat mull) from the litter, and the latter is pressed into bales by steam or hydraulic power, or in some cases by hand labour.

According to some experiments at the South-

Eastern Agricultural College the absorptive *power of peat-moss litter was found to be five times as great as that of straw.* The value of the litter depends chiefly on the amount of liquid it can absorb, and there is considerable difference in different samples. In three samples examined at the Armstrong College, Newcastle-on-Tyne, it was found that one sample was capable of absorbing 11 times its own weight of water, while two other samples took up 9·4 and 9·2 units of water. This difference is of considerable importance, a ton of the better sample being capable of absorbing as much liquid as 1¼ ton of the other samples. It is also important that moss litter should be easily broken up, as when it remains in lumps these are found in the dung unsaturated with liquid manure. See art. MOSS LITTER MANURE.

An exhaustive account of the methods of manufacturing moss litter, with a plan of a small factory, is given by Dr. Zailer in Zeitschrift für Moorkultur, 1906, p. 76, which should be consulted by those interested. Briefly, it may be said that there is a very great variation in the suitability of different peat for this purpose, and it is important to take into account its botanical composition. Sphagnum moss is probably the best, while peat from Cotton Grass (Eriophorum) is excellent for mixing. Hypnum moss is not very suitable owing to its brittleness and lack of fibre, but may be mixed with other kinds. The first step is to drain the moor of its surface water, so as to enable it to be worked. The digging of the peat is done by hand, in order to avoid injuring its fibrous character, and the factory must be situated in the immediate vicinity in order to avoid expensive carriage. Space must be provided for storing the dry peat which is to be worked up, and also the moss litter when it is produced. The machinery is simple, consisting merely of a 'wolf' machine for tearing out the fibre, and a baling press. Power may be supplied either by horses or by water. Dr. Zailer gives the cost of a small factory as follows: Building, using local materials, £63; wolf machine, £36; 2-h.p. wheel with bands, &c., £19; hand press, £36; tools and sundries, £36;—total, £190. This would produce roughly 10,000 cwt. annually, and the total cost of manufacture is not reckoned to exceed about 7*d.* per cwt. These prices apply to Austria, where wages are possibly lower than with us. Dr. Zailer suggests that a small factory of this kind could be worked co-operatively to supply farmers with litter.

PEAT DUST OR PEAT MULL.—This is the dust resulting from the manufacture of litter, and is an excellent disinfectant. As it is practically free from bacteria it forms a very useful packing material for fruit, meat, and fish, and it is stated that fish packed in it will keep perfectly fresh for several weeks. It is also an excellent deodorizer in closets and stables. Walls filled or padded with peat mull are rendered warm and dry, and beds made of it are extensively used in asylums and hospitals on the Continent on account of its sanitary properties.

PEAT FIBRE.—This does not appear to be made in Great Britain, but large factories for the manufacture of peat fabrics exist at Pari[s], Admont in Austria, Weort in Holland, Olde[n]burg in Germany, and Stigen in Sweden. I[t] is usually mixed with from 6 to 25 per cent o[f] wool or cotton and made into horsecloths, arm[y] blankets, saddlecloths, carpets, mats, &c. It i[s] also used in conjunction with wool for the manu[]facture of underwear, and also for bandages an[d] other surgical purposes. The crude fibre is sepa[]rated from the peat, treated with dilute alkal[i] and afterwards carded and bleached. Peat fibr[e] is also made into pulp for papermaking.

OTHER PRODUCTS.—Many other products are or have been manufactured from peat. Paraffin is obtained by destructive distillation, and from this paraffin candles are produced. 'Heloxyle' is the name given to peat fibre compressed and hardened by a special process into sheets, tiles, plates, and blocks for various building purposes, which are used for lining walls. Pasteboard made of 40 per cent peat fibre and 60 per cent wood shavings is in common use in Germany and Sweden, being stronger, lighter, and cheaper than pasteboard made in the ordinary way. Peat molasses for feeding cattle is made by heating the molasses and mixing it with peat mull while hot, in the proportion of 20 parts of mull to 80 parts of molasses. It is claimed that excellent results are obtained from the use of this food. [R. J. T.]

Peat-land, Reclamation of. See BOGS, RECLAMATION OF.

Peat Moss. See arts. PEAT AND PEAT PRODUCTS and MOSS LITTER MANURE.

Peats, Cutting of.—Peats have been used from time immemorial as fuel in districts in Great Britain and Ireland where moss forms a natural source of supply. In some parts of Scotland and in Irish country districts peat is the chief fuel. In many cases, however, it is supplemented by the use of coal. The mossy soil is very retentive of moisture, and there are large tracts so loaded with water as to form practically a bog or morass. Other tracts, while not so spongy, are often too soft for vehicular traffic, the wheels cutting through the surface covering of grass or heather very quickly. And in consequence peats have to be cut from their bed and conveyed by manual labour considerable distances from where they are found, to a part of the adjacent ground where they can be reached by horses and carts and thence conveyed to the farms or distilleries where they are to be consumed, or to railway stations or canals for conveyance to their destinations.

A peat moss is an important feature in the life of many a rural community, and laws for the regulating of the casting of peats have been in vogue for a great length of time. Any one transgressing the regulations can be smartly dealt with; if not in one way, in another. The 'moss' is laid out into sections so that each family in the district served by it can have a part allotted. There is the bank or trench from which the moss is dug as in a soft bog, and 'cast' as in a stiffer part, and there is the space of surface ground on which the peats are laid out to dry in the sun and wind. An ideal system is adopted on the Seafield and other estates

in Inverness-shire, Banffshire, and elsewhere. The mosses are under the charge of moss grieves appointed by the proprietors of the estates, and no tenant or other person is at liberty to cast peats on any part of the property except with permission of the moss grieves and on ground to be pointed out by them. Any person cutting peats without such permission is liable in a penalty of say 1*s.* per square yard. Each tenant has to pay at the rate of 6*d.* for each spade's casting of peats per annum, payable to the moss grieve when the ground is marked off. On many estates, however, the tenants are not charged anything, even although the moss, as generally happens, is not on the land rented by them—that is, for the moss as a moss, it being laid down in the farm leases that they are to have peats. Without peats there would be no use in taking a farm. A spade's casting of peats is about 9 ft. lineal of peat bank and 60 yd. lineal of lair of the breadth of 9 ft. Each lair will thus contain 180 sq. yd., and as one barrowful of peats occupies about 1 sq. yd. there would thus be 180 or nine-score barrowfuls on each lair. Allowing 30 barrowfuls to a cartload, this would amount to six loads of peats in each casting. The number of spades' casting of peats to which each tenant would be entitled has to be regulated and determined by the moss grieve according to rental, say as follows: Tenants paying rents of £5 and under, say two spades' casting; tenants paying above £5 and not above £10, three spades' casting; above £10 and not above £15, four spades' casting; above £15 and not above £20, five spades' casting; above £20 and not above £25, six spades' casting; above £25 and not above £30, seven spades' casting; above £30 and not above £40, eight spades' casting; above £40 and not above £50, nine spades' casting; £50 and upwards, ten spades' casting. Of course the amount would have to be regulated by the quality of the peats, as some are of better quality than others; and again a considerable margin would have to be allowed, as more or less fuel would be required according to the severity or mildness of the season. Then sub-tenants or servants of tenants are allowed to cast in room of the principal tenants if authorized by them, but only on ground to which the principal tenants have right themselves. Cutting of peats for sale is prohibited unless special written permission be granted by the proprietor or his factor; and in the event of such being granted, a charge of 2*d.* per cartload of 30 barrowfuls in name of lordship shall be leviable by the proprietor. When liberty shall be granted to the tenants they shall be bound to cast them in a regular manner and on allotments set apart by the moss grieve, and they shall carry the banks equally forward without pitting, and lay the surface turfs regularly down in the bottom of the peat hags, and make channels when necessary to free the hags from water, and in all cases they shall submit to and obey the regulations and orders of the moss grieve under a penalty of 20*s.* for each offence, or in default be excluded from the moss.

It is very necessary, if the amenity of the moss is to be conserved, to see that each bank is cut straight from end to end. Were the tenant to cut a pit in it because the moss in that part was better than in another, and were he to neglect to keep it drained, the result would be both unsightly and dangerous. Water would collect in many cases deep enough to drown stock or game, not to mention human beings falling into it. Three peats or 5 to 6 ft. is the usual depth of the bank face; but if the ground is suitable, moss is cut much deeper. The farther down one digs the better is the quality, the peat drying a hard black, and lasting better in the burning, although the work of casting it is more laborious owing to the distance it has to be lifted up the bank and its 'crumbly' character.

The casting of the peats is an important part of the year's work for all those dependent on this commodity for their fuel. The work is undertaken when the weather gets warm enough in summer, whilst if the season has been favourable the dried peats are carted home in the autumn. However, if the season is wet it may be the winter or the following summer before they can all be got home, so it is the endeavour of careful people to have two years' fuel in the stack. The casting, spreading, setting, and stacking of the peats are done by the farmer, his family, and his servants as a rule. As the peats are cut out of the bank by the 'caster' with a special implement called a tusk, they are removed in barrows and tumbled out into little loose heaps. In a few days, depending on the weather, the peats are spread out on the ground from the small heaps. In another day or two they are set up on end in rickles of six, eight, or a dozen peats. When they are dry they are carted home, or put into larger rickles or into stacks. The stacking is important, and great care has to be taken to see that the stack is watertight. Shaped like a brick, the peat lends itself readily to stacking, and with the sides and ends of the stack built up, and the roof shaped like that of a house and thatched with turfs, the fuel is safe from wind and rain.

The expense of casting and winning peats varies with the wages ruling in the various districts. In the case of distilleries, most of the casting, &c., is done by contract. In the Glenlivet district of Scotland, where most of the malt distilleries are situated, the casting, weathering, and stacking of peats costs 1*s.* 3*d.* to 1*s.* 6*d.* per yard, according to the quality of the moss and the position or condition of the bank. It costs 1*s.* 4*d.* per yard for foggy quality and 1*s.* 5*d.* per yard for hard quality, cut, dried, and stacked on a dry foundation beside where cut. If they have to be wheeled out to where carts can reach them, this costs 2*d.* or 3*d.* per yard more. After this comes the carting to the distillery; and the cost of course varies, as in some cases they have to be carted a considerable distance and thereafter railed to their destination. Winning peats from a watery bog, as in Ireland, takes longer than from a firm moss, and the cost is greater. [L. G.]

Peck, a measure of capacity containing 2 gal. or one quarter of a bushel. The imperial peck contains 554·5 cu. in., but the measure varies locally in different districts.

Pedigree may be defined in two ways: *it* is either the elements of which a family genealogy is composed, or the record of that genealogy. Radically, the word itself, which is supposed to be derived from the Latin terms for a *crane's foot*, has reference to the record, and not to the constituents of the record; and when so regarded, the term 'pedigree record', so often heard in connection with stock-raising, is a pleonasm. A pedigree is the record of a genealogy, and an animal without such a record is not incorrectly described as unpedigreed. For practical purposes, as a guide in breeding, and especially in mating the male and female, an animal of the most aristocratic lineage, whose breeding is not recorded and cannot be certainly traced, is just as useless as an animal of less illustrious descent, whose breeding is on record. Indeed the advantage is with the latter, because the breeder in manipulating his stock for breeding purposes knows what he is doing with such; but he is entirely in the dark in operating with the unpedigreed animal, even although its blood be of the best. Hence the vast importance of herd books, stud books, and flock books, and their increasing popularity during the latter part of the 19th century.

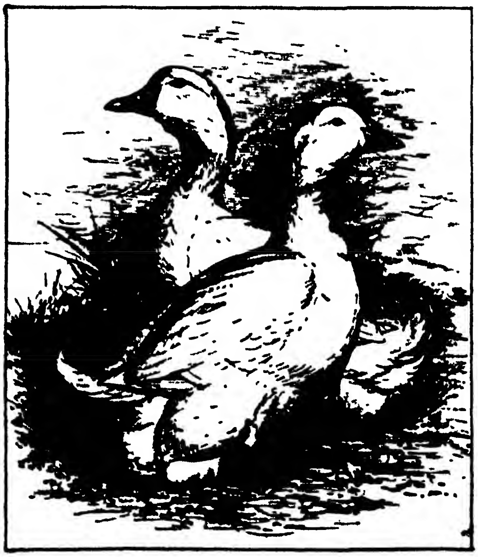
The oldest pedigree record is the General Stud Book, under which the English Thoroughbred has been developed and made the marvellous engine for speed and endurance that he is. The oldest record of cattle pedigrees is George Coates's Herd Book of Shorthorn Cattle, the first volumes of which were compiled by the enthusiast whose name it bears. To him breeders of every kind of stock are indebted for laying down the great principle of making the dam the basis of pedigree registration. All the more modern registers are in greater or less degree modelled on Coates's Herd Book; and whatever variations may be found in each as to matters of detail, all are faithful to the root idea that pedigree should be traced through the female side.

Breed societies are the inevitable result of the growing appreciation of the value of pedigree. As time went on, it was felt that standards of admission to a pedigree record were indispensable, and such standards could not be left to be determined by any one individual, no matter how trustworthy he might be. The advent of the breed society was the necessary consequence of the ascertained results of breeding in line under the guidance of a register. Controlled by an individual a pedigree record could never be more than a register. One animal's pedigree in the register would be longer or shorter according to the caprice or intelligence of the breeder. Controlled by a breed society, representative of the great body of patrons of one particular breed, a minimum standard is fixed, and animals whose record of ancestry falls short of this standard cannot be included in the stud book, herd book, or flock book. The chief danger in connection with this work lies in the tendency to 'close' a record too soon—that is, to make the minimum standard of admission registered sire and registered dam, as in the General Stud Book and several of the cattle and sheep registers. If it were certain that within, say, the first twenty years of the life of a pedigree record all the recognized families or animals of merit had been recorded, this policy would not do much harm. But when, as a matter of experience, the reverse is found to be the case, the sound policy is that upon which Coates's Herd Book for Shorthorn Cattle has been compiled. This policy consists in fixing the number of top crosses for bulls at five registered sires, and the number of top crosses for cows at four registered sires. By this means a minimum standard of purity is fixed, and the door is left open for men who have neglected registration to breed up their stock to the standard demanded by the breed society. This system gives a guarantee of practical purity and an authentic record, while at the same time it encourages breeders to improve their stocks by the continued use of high-class pedigreed sires. [A. M'N.]

Peewit, a name applied to the Lapwing by reason of its familiar cry. See LAPWING.

Pegomyia (Anthomyia, Chortophila) betæ is the Mangold and Beet fly. It attacks the leaves of its food plants, the eggs being laid in patches on the under surface, and the maggots feeding on the inner substance of the leaves. The flies appear in the spring, and there are two or more broods during the summer and autumn. Washes are generally of little use, though paraffin emulsions have had some beneficial effect. The application of stimulating manures helps the crop through the attack, and hand-thinning the infested plants is sometimes practicable. [C. W.]

Pekin Ducks.—In the United States, and also to a lesser extent on the continent of Europe, Pekin Ducks have won a leading position. Upon the great duck ranches of America, where large numbers of ducks are bred, Pekins



Pekin Ducks

alone are kept; but these conform in shape more to the Aylesbury type, differing in shape from European Pekins, which are long in body, upright in carriage, and have a canary-coloured plumage like the original importations. The Americans, on the other hand, have bred for pure-white, thus following Aylesbury ideals. Between the two breeds there are other noticeable differences. Instead of having the boat shape of the Aylesbury, with line of breast fairly level, the Pekin is much higher in front than behind, the posterior aspect having a massive appearance, due to a thick covering of soft feathers. The legs are dark-orange in colour, and the head and neck thick, the skull standing out very prominently. The bill is of a bright-orange colour, in contrast to the flesh colour of the Aylesbury, which is an absolute sign of purity of race. Many Aylesburys show a yellow bill, due to the fact that soon after the Pekin was introduced there was a considerable infusion of the newer breed with the Aylesbury. This proved beneficial to the Aylesbury, as it was rapidly losing vigour as a result of inbreeding. The Pekin drakes weigh 7½ to 9 lb., and ducks 6 to 7½ lb. In respect to economic qualities the Pekin is probably the most prolific of all the larger races of ducks. It is not so rapid in growth as the Aylesbury, taking two or three weeks longer to attain a killing size, and then is not so fleshy, due to the profuseness of feather. A cross between the two breeds gives rapid-growing, meaty ducklings. The Pekin is wonderfully hardy, active, and an excellent forager, but the ducks are not very reliable sitters and mothers. [E. B.]

Pelargonium, a large genus of tender plants of the nat. ord. Geraniaceæ, distinct from the genus Geranium, with which it is often confused. Some of them have tuberous rootstocks. Most of the species are natives of the Cape of Good Hope, but few of them are cultivated, having been superseded by the enormous number of fine hybrid forms divided into four sections, Show, Fancy, Zonal, and Ivy-leaved, which are still being constantly added to. Few plants exhibit the art of the gardener more adequately. Some kinds which have not fine flowers are grown for their scented leaves, which are said to resemble the odours of apples, roses, &c. The four sections of Pelargonium are quite distinct, and with the exception of the Zonal and Ivy-leaved do not interbreed. Zonal Pelargoniums include the so-called bedding 'Geraniums' in their various variegated-leaved forms, and the Zonal 'Geranium' proper, which is grown as a winter-flowering greenhouse plant. They are increased by cuttings taken at any time of the year, but preferably in February. Plants for winter flowering should not be allowed to flower until the end of August. Show Pelargoniums are of sturdy and compact habit, and have much larger flowers. They may be grown on into very large plants bearing a great number of trusses of flowers at one time. They flower in spring and early summer. The cuttings are usually inserted in July. A rich compost is used for the production of large flowers, and liquid manure is given when the plants are well established in the flowering pots. Fancy Pelargoniums have smaller flowers, but they are prettily marked, and abundantly produced. The plants may be grown for several years in pots of the same size, the soil being annually renewed. Ivy-leaved Pelargoniums are of a semi-climbing or procumbent habit, and are extremely useful for furnishing baskets or window boxes, and for covering walls, and training up pillars in greenhouses. The improved varieties raised of late years are the result of crosses with the Zonal section. Pelargoniums are but little attacked by insects and diseases, but they require fumigating now and then to keep off or destroy aphides which infest them. [W. W.]

Pelargonium. — Parasitic Fungi.— The cultivated varieties, better known perhaps as Geraniums, are susceptible to disease chiefly during the period when cuttings are being rooted. They damp off and become coated with a grey mould; this fungus (*Botrytis*) is common on dead plant-remains, but in moist conditions and when plants are not growing actively it may become a dangerous parasite. *Treatment.*— Reduce moisture, afford better ventilation, and avoid overhead watering; cuttings which are well matured and hardened are least liable to this form of damping-off. Leaf spots accompanied by minute fungi may occur in summer; these may be checked by burning the spotted leaves, and plants attacked in this way should not be used for cuttings. The foliage of greenhouse Pelargoniums may become spotted with yellowish watery spots, generally regarded as symptoms of excess of moisture and insufficient light, the remedy being a cooler, drier soil and increased ventilation. [W. G. S.]

Pembroke Cattle. See Welsh Cattle.

Penal Rents. See Agricultural Holdings Acts.

Penistone Sheep, although white or light-grey on the face and legs, belong to the group of sheep known as the Heath breeds, of which the Highland Blackface and the Lonk are prominent examples. Both the ewes and rams have strong horns, like the Lonk. The breed derives its name from Penistone, the highest market town in England, and it belongs to a neighbouring exposed district on the confines of Yorkshire, Lancashire, and Derbyshire. The mutton is of specially good quality. The form of the animal is coarse and ungainly, the bones of the limbs strong, the feet large, the face long with good strength of nose and depth of jaw, indicative of a robust constitution. From other sheep the Penistone is distinguished by a long and muscular tail, which, however, does not carry large masses of fat as in some Eastern breeds. The yield of fleece is medium in quantity for a mountain breed, and the wool, like that of its blackfaced relatives, is liable to be mixed with 'kemp' or dead hairs.

The breed was pretty widely distributed about a hundred years ago, as is seen from the records dated 1807 of the 'Orders of the Shepherds' Society', which held its two annual meetings at Saltersbrook for the exchange of stray sheep, and drew 'sheep keepers' from Penistone and seven adjoining 'Liberties'. It is one of the oldest in the whole country, dating back to the

time of the Romans, who first established their woollen manufactures at Winchester. It was from fabrics woven of English wool that the finest and most expensive robes were made during the luxurious era of the Roman Empire. [R. W.]

Pepper.—Several species of Piper (nat. ord. Piperaceæ) are of great economic interest and value, and all of them indigenous to tropical countries. *P. Cubeba*, Linn. f., yields the Cubebs, a native of Java and the Moluccas, but also cultivated in India. *P. longum*, Linn., is the Long Pepper, a perennial shrub, native of the hotter parts of India. It is cultivated in Bengal and South India, and is the pepper chiefly exported from Calcutta. It is propagated by suckers, and requires a rich, dry soil; the suckers are transplanted from nurseries on the commencement of the rains, and placed 5 ft. apart each way. Radishes, barley, brinjals, &c., are interplanted. The fruits are gathered in January, and preserved by drying in the sun. *P. Betle*, Linn., the Betle or *pán*, is a perennial diœcious creeper, probably originally a native of Java, but extensively grown in India on account of its leaves. It requires a uniform temperature and constant degree of moisture. To attain these conditions it is raised within specially constructed houses (*burejas*), the walls and roofs of which are constructed of reeds tied together in parallel lines, so as to admit a diffused light and protect the plants from the severity of the climate. *P. methysticum*, Forst., yields the *Kava* root which is chewed in the Society and other Pacific Islands, the ejected saliva being preserved, fermented, and prepared into a beverage which is slightly intoxicating and narcotic, but is said to quench thirst better than any other liquid. The property of the root is due to a resin which, like cocaine, produces local insensibility.

P. nigrum, Linn., yields the Black and White Peppers of commerce, the *gūlmirch* of India. This is a climber, usually diœcious, wild in the forests of Travancore and Malabar, but now extensively cultivated in most of the hot damp tracts of South India generally, and has been conveyed to the Straits Settlements, the Malaya, and elsewhere in the Tropics. The following imports of pepper into the United Kingdom during 1907 may be accepted as to some extent indicating the relative importance of the modern countries of production: Straits Settlements 9,084,392 lb., valued at £213,150; Madras 1,600,970 lb., valued at £31,489; Siam 1,359,274 lb., valued at £35,082; Java 1,036,020 lb., valued at £28,282; and French Indo-China 817,850 lb., valued at £16,904. But India exports very largely to other countries besides the portion sent to the United Kingdom. In 1906–7, for example, her foreign exports were 9,499,089 lb., valued at £220,082, of which Italy took 2½, Germany nearly 2, the United States 1½ million pounds. Moreover, the local consumption within India itself is probably very nearly as great as its foreign exports, so that India still holds an honoured position in the world's supply.

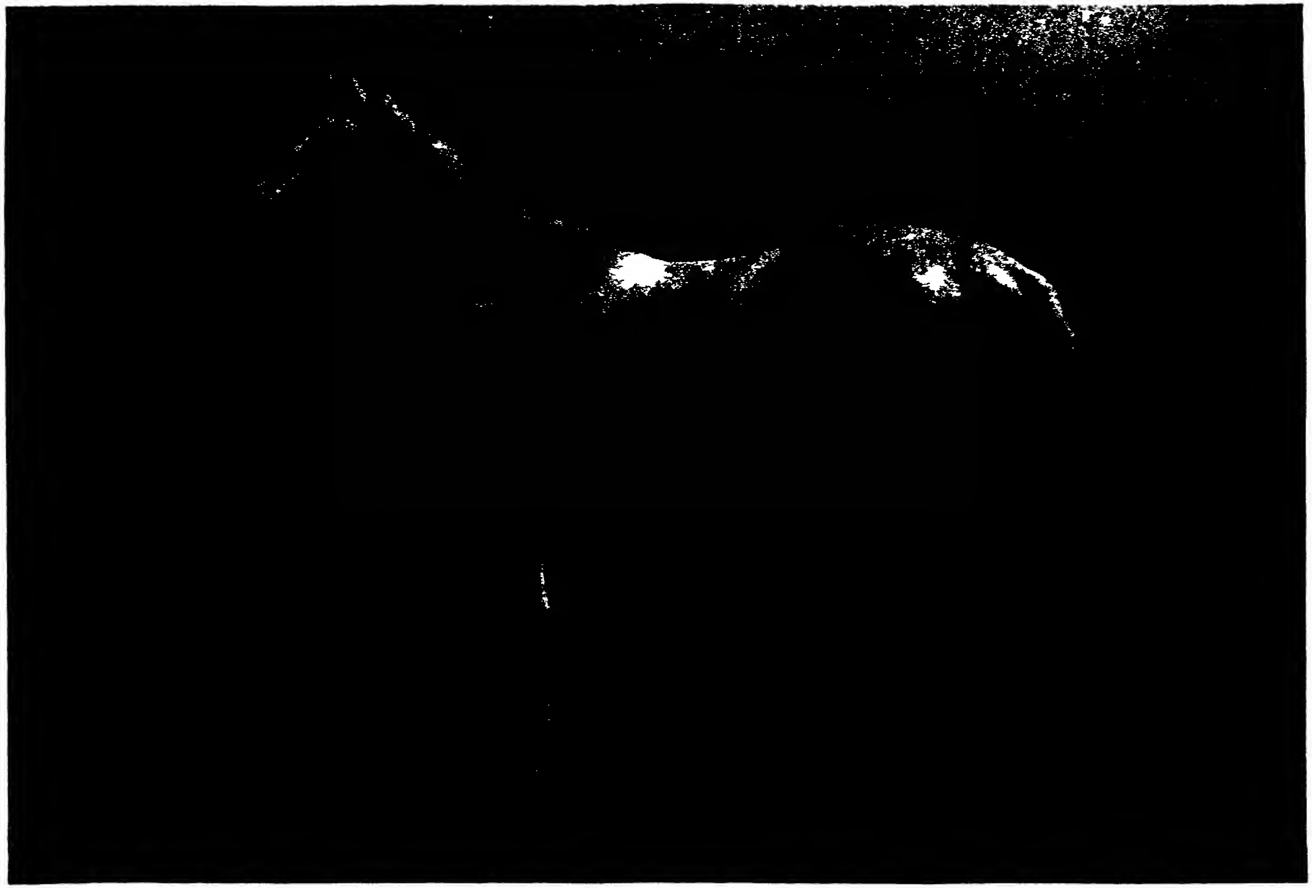
Cuttings, layerings, or seeds are put down in June to July in rich soil not subject to excessive moisture, and liberally manured with leaf mould. Trees or palms are often selected (especially those with rough barks, such as the species of Erythrina), for the vines to climb upon, or poles (12 ft. long) are provided and arranged in rows 7 ft. apart each way, greater distances being, of course, necessary with living supports. Trees have, as a rule, to be pollarded so as to keep them within workable heights, and to prevent too dense shade. Healthy vines may produce stems 20 to 30 ft. long, and in some plantations the young shoots are pruned so as to cause them to branch and to check too great elongation. The young plants are placed in specially prepared and richly manured holes some little distance from the supports. The chief shoots are then guided to the supports, and all useless suckers removed. In three years' time the vines begin to bear, will be in full yield by seven years (tenth year from planting out), and may continue to yield crops for a like period; but each year the yield, with advancing age, may be noted to be decreasing, and the time is soon thereafter reached when it will be more profitable to uproot and replant. As the roots lie close on the surface a dressing with manure yearly is necessary, as also careful weeding; and to protect the roots from being scorched it is desirable to cover them with straw or dried leaves. In selecting stock, care must be taken to observe that some plants are almost entirely staminate, others almost entirely pistillate. A fair amount of staminate plants is of course indispensable to success, but the greater majority should be plants that fruit freely. The fruits are in the form of small spikes of round berries, at first green, then red, and, when over-ripe, palĕ-yellow in colour. As soon as they begin to turn red, the spikes should be collected, the berries dried in the sun, stripped off the stalks, and winnowed to free them from dirt. The yield varies from ½ lb. to 7 lb. per vine, or from 450 lb. to 6000 lb. per acre. White Pepper is simply Black Pepper the berries of which have been deprived of their outer covering. This is accomplished by piling the berries in heaps and causing them to ferment. The skin is thereby softened, so that it separates when trodden under foot and washed in water. The dried berries are then packed in bags in the same way as with the Black Pepper. [G. W.]

Peppermint. See Herbs and Herb Industry, also Mentha.

Perch.—In square measure the perch is equal to 30¼ sq. yd., in lineal measure to 5½ yd.

Percheron Horse.—The Percheron Horse is one of the best known of all the Continental breeds, and in no part of the world are its merits more highly appreciated than they are in America; but in this country its popularity is not great, for the horse has a reputation for softness when compared with our Shires, Clydesdales, and Suffolks. The stronghold of the Percheron is in the district of Perche, to the north and west of Normandy.

Two varieties of the breed are recognised, the heavy and the light; the latter of which is to be chiefly found in the districts of Mortagne, Moulins-la-Marche, Aigle, and Meslesur-Sarthe; whilst the heavier breed comes from the neighbourhoods of Vilvaye, Saint-Corme, and Mamers. Of the two the heavy



PERCHERON STALLION—"THOR". AMERICAN BRED

breed is by far the most in request both at home and abroad, as they are useful for heavy draught purposes, whereas the lighter one is more regarded as a speedy trotter. Whether his value in the latter capacity is great is, however, a matter of doubt when his performances come to be compared with those of the American Trotter, as records of 3 min. 50 sec. for 1½ mile, and of 6 min. 2 sec. for 2 miles, are far behind those which reach us from the other side of the Atlantic.

Some years ago the London General Omnibus Company gave the breed a good chance, as they imported a considerable number of Percherons of an intermediate grade between the heavy and the light varieties, and used them for street work. The experiment, however, did not prove satisfactory, as the foreigners neither worked so well nor, as a rule, lasted so long as the British-bred horses, the result being that all idea of repeating the importation was abandoned. Curiously enough, in America, Percherons of a still heavier type are regarded very favourably as good workers on the farm and for heavy draught purposes on the roads, though there are signs which justify the prediction that the Clydesdale and Shire will gradually assume the premier positions as heavy horses in the United States. A good deal of the popularity of the Percheron in America is due to his grey colour, which is quite the best-liked colour of all there for heavy horses; but the prejudice against bays and browns is gradually dying out.

Arab stallions were used for the improvement of the Percheron about the year 1760, since which time both English and Danish sires were imported with the object of still further developing the breed, which, however, has been practically bred uncrossed for a century past. The fine temper and other virtues of the Percheron still mark the Arab descent.

The general appearance of the heavy type of Percheron very much resembles that of the Suffolk horse, but the former is not so heavy in crest. Like the Suffolk he carries no feather upon his legs, which are short and flat in bone, but the latter is not of such a good quality as that of the English horse. The Percheron is a very neat-headed animal, with a nice full eye and good expression, his ears being small, but his neck is apt to be short and plain. If not in big condition his middlepiece appears small for his two ends, as his quarters are usually good, though in some cases his tail is set on low, and if this is the case it gives him a mean appearance. As a rule his feet are very good, but if kept at heavy work on hard ground his joints often give way, which fact, associated as it often is with the taint of softness, renders the Percheron, in the opinion of British horse-owners, inferior to our native heavy draught varieties. The usual height is about 15 hands 3 inches, but, of course, taller specimens of the breed are often met with, and there are also plenty of smaller ones not much above 14 hands to be found. The constitution of the breed is robust, and they are not so liable to meet with accidents as are some other breeds, as their easy tempers do not render them liable to injuries through accidents which might befall more excitable breeds. The prevailing colour amongst them is grey, but bays and roans are by no means uncommon, and chestnuts are also to be met with. [V. S.]

Peregrine Falcon. See FALCONS.

Perennial Rye Grass. See RYE GRASSES.

Pericarditis, inflammation of the heart sac. See HEART, DISEASES OF.

Perigord Pig.—The Perigord, which is sometimes known as the Gascon or Limousine, is bred more especially in the mountainous districts in a number of French cantons, including Loire, Rhone, Creuse, Dordogne, and Corrèze; and in the neighbourhood of the Pyrenees. It is of average size, well formed, but rather fine in frame; the head is broad when looking from the front, the ears are rather long and of average width and slightly drooping, while the flanks are of medium length: the snout corresponds with the ears, while the tail is set rather low. Taking the pig altogether, it is a well-fleshed and well-rounded animal. The skin is black and white, the ears and head being pure-white; all-white or all black pigs being very seldom found where any pretension is made to keep them pure. Breeders of the black Perigord, however, seek to keep the neck, the head, the loins, and the back pure-black, but in this they apparently very seldom succeed, for pigs with black heads and ears are very common, with unsymmetrical patches of black on the upper parts of the body. The development of the Perigord is somewhat precocious, more so, indeed, than the majority of French varieties. It is easily fattened, while its hams are famous in France on account of their flavour and tenderness. The sows are prolific, and supply a good quantity of milk for their litters. It is sometimes crossed with English breeds with advantage. [J. Lo.]

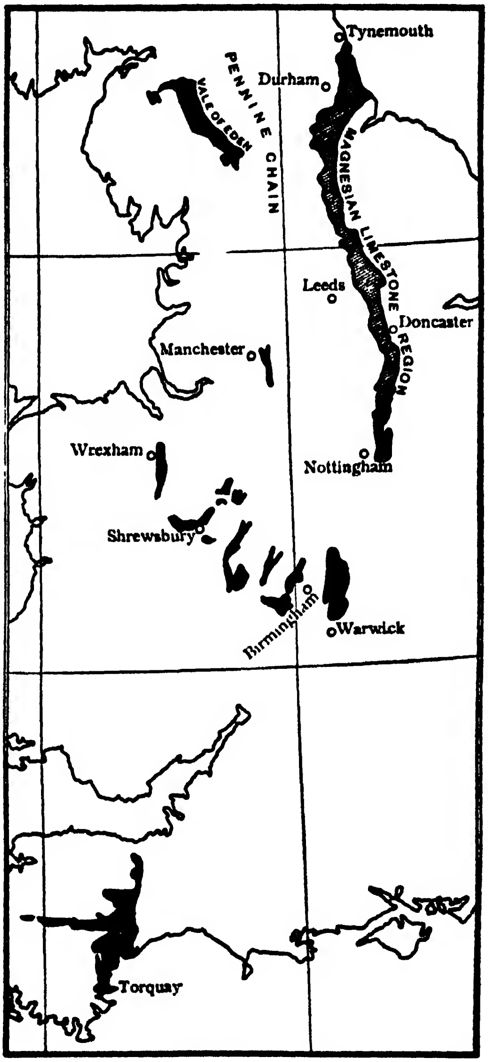
Peritonitis.—The peritoneum is a serous membrane which lines the abdominal cavity and invests all the organs therein contained. Inflammation of this membrane is easily provoked, rapidly spreads, and frequently terminates fatally. All animals, including birds, are subjects of peritonitis. It may be primary or idiopathic, but more commonly in domesticated creatures follows upon some prior inflammatory state of an organ, from an injury or surgical operation, as a sequel to colic in horses, to castration and spaying, to parturition, and to wounds and injuries of the parietes of the belly. The horse is so susceptible to this disease that veterinarians feared to insert a trochar and canula into the distended bowel in flatulent colic, prior to the better understanding of aseptic surgery. It is now frequently practised. Peritonitis is the *bête noire* of the castrator. It may be acute and soon carry off the victim, or become chronic and induce dropsy among other sequelæ. The symptoms are not uniform or typical, from the fact that it is usually secondary to some other malady which obscures them. Pain of a colicky nature (see COLIC) is present, grinding of the teeth, restlessness, lying down and groaning, looking backwards, kicking at the belly. The temperature is invariably high, but the

conduct of the animal may be quite unlike what we have above indicated. He may on the contrary seem narcotized and stand persistently, but always wearing an expression of misery and hopelessness. The pulse is small and hard, and palpitation of the heart increases as the pulse becomes feeble. The belly is at first drawn up, but spreads again later. It is tender to compression. Constipation is invariably present. Urination is difficult, and frequently attempted without success. Appetite uncertain at first, and lost as the malady progresses. Breathing short and superficial, or deep and laboured. If death does not occur, or early convalescence, then the symptoms abate, but the disease takes on a chronic form. Exudates form, and compress the abdominal organs—the intestines being found after death enshrouded in a thick membranous covering which has gradually restricted their functions. *Treatment* varies greatly, from cold andaging to stimulation with mustard and turntine. Opium and other anodynes are given ubdue pain, while waiting for a natural rally. [H. L.]

rmian System.—This system is closely to the Carboniferous in many countries; British Isles, however, owing to the rrence of considerable earth movements at close of Carboniferous times, the beds rest conformably on the other members of the eozoic group, and have often been linked h the overlying Trias under the common nte of *New Red Sandstone.* Permian strata hus rest, as we trace them southward, on Coal Measures near the Tyne, on Carboniferous Limestone in the valley of the Swale, on Millstone Grit near Harrogate, and again on Coal Measures from Leeds to Nottingham.

The Lower Permian beds received in Germany the quaint name of *Rothtodtliegendes*, or 'red dead layer', since a bed of copper ore overlay them, and mining ceased when they were reached. This series is represented in England by sandstones, usually red, with breccias among them, derived from the weathering of earlier strata on a coarse scale, and possibly marking a land surface. Variegated clays and shales often overlie these sandstones, and are succeeded in the north of England by a buff-coloured marine magnesian limestone, which may be as much as 600 ft. thick. The so-called Marl Slate which immediately underlies this limestone is a well-bedded shale with thin layers of limestone. Above the Magnesian Limestone, the system closes in places with red clays and sandstones containing gypsum, and indicating a return to terrestrial conditions.

The Permian beds of eastern Devonshire are red sandstones and breccias; they form the red cliffs from Torquay to the valley of the Exe, and their colour is conspicuous on the steep fields along the coast. The red Permian sandstones appear in the English midlands generally round about the inliers of Coal Measures, and overlain by Triassic strata. The Upper Permian, with its distinctive Magnesian Limestone series, is exposed in a long band from Nottingham to the Tyne, and clearly at one time extended farther to the west. In Cumberland, however, only the sandstone type is present, with limestone breccias, styled *brockram*, derived from the adjacent Carboniferous series. The beds often regarded as Permian in the south of Scotland will be discussed in the article on the Triassic system. Only two or three small exposures of Permian beds occur



Sketch-map showing Distribution of Permian Strata in Britain. Ordinary type (conglomerates, sandstones, and shales) shown black; magnesian-limestone type shaded

in Ireland, in the counties of Down, Tyrone, and Armagh; the fossiliferous magnesian limestone type appears at Holywood and near Stewartstown.

The Permian beds in Britain usually form low ground, in welcome contrast to the Carboniferous moorlands with which they are associated. The descent from the Yorkshire highlands thus brings us to cultivated Permian

lands upon the east, and the Vale of Eden in Cumberland has been cut in Permian and Triassic strata amid a region of rain-swept and forbidding moors.

The famous potash salts of central Germany result from the drying up of lagoons or lakes in Upper Permian times, and are overlain by the lowest beds of the Triassic system.

[G. A. J. C.]

PERMIAN SOILS.—The soils of the Lower Permian series are very similar to the soils of the Trias (see art. TRIASSIC SYSTEM). In the valley of the Exe in Devonshire the series develops a rich loam or sandy loam resting on a more clayey subsoil. Very fertile soils derived from Permian rocks occur in the Vale of Eden in Cumberland, derived in part from the beds of limestone breccia. Where the system appears in central England, for example in the country round Coventry and Kenilworth, the land is of superior quality, as is indicated by the flourishing oaks and elms which abound in these districts.

All the Lower Permian soils are light and friable, and they commonly possess a rich red colour; they have good natural drainage, are easily cultivated, and are particularly suited to such crops as barley and turnips, while the grasslands of the series make valuable sheep pastures. Some of the finest farming in the British Isles is to be met with on this formation.

The slaty marl beds which overlie the Rothliegende series occur only in thin strata, and do not seem to influence, in any marked degree, the fertility of the districts in which they appear.

The characteristic soils of the Magnesian Limestone series are thin, light, brown-coloured loams, producing land not unlike that of the low-level Carboniferous Limestone formation, but not so fertile. It is popularly supposed that the magnesia occurring in these soils has an injurious effect on the vegetation. As the substance exists mainly in the form of carbonate, this belief is probably erroneous, and cultural experience shows that it does not seem to exercise any deleterious influence, even in soils in which it is present to the extent of 4 or 5 per cent. Magnesian Limestone soils are more adapted to tillage than to pasture; they are very easily cultivated, and when the seasons are not too dry they are capable of producing remunerative crops of barley, turnips, potatoes, and even wheat. On the other hand, the grasslands are of an inferior type. Lime does not appear to benefit the lands of this formation, but they readily respond to liberal dressings of farmyard manure. M'Connell states (Agr. Geol., p. 188) that guano does not suit the Magnesian Limestone soils of Yorkshire, and that the Derbyshire representatives are not benefited by applications of liquid manure.

The Magnesian Limestone is sometimes burnt for agricultural purposes. [T. H.]

Perry.—Perry is a fermented beverage made from the juice of pears. In general character, both as regards its chemical composition and its method of production, it closely resembles cider. It is, in fact, extremely difficult at times to distinguish by flavour and appearance alone the produce of certain types of apples and pears. Owing to this close resemblance, it is a by-no-means uncommon practice in the perry-producing districts to blend cider and perry.

Perrymaking is not a widely spread industry, and is confined mainly to the cider-producing districts of France, and the counties of Gloucester, Hereford, and Worcester in the British Isles. It is occasionally met with also in the adjacent counties.

Vintage varieties of pears bear much the same relation to the market varieties as is the case between vintage and market apples. The number of kinds of vintage pears is comparatively small; and although, as in the case of vintage apples, it is possible to group them into the three classes of 'sharps', 'sweets', and 'bittersweets', wide variations in chemical composition are not generally found, and the necessity for blending is, therefore, not as a rule so pressing for perry as for cider. The most popular perry varieties are Barland, Butt, Holmer, Black and Yellow Huffcap, Moorcroft, Oldfield, and Taynton Squash. All of these are fairly widely grown in the perry-producing counties, and under favourable circumstances yield perries of high quality. Taynton Squash, however, has the disadvantage of ripening very early; while Butt generally throws a very heavy crust in bottle, and requires two or three seasons to mature properly. Oldfield is probably the most generally useful variety, cropping well and ripening fairly late. Its juice ferments slowly, and as a rule yields a perry suitable for bottling. Blakeney Red is a variety very largely grown; but, although a heavy cropper and a very juicy pear, it is only a second-rate vintage kind, the perry being thin and lacking in flavour.

The methods used in the manufacture of perry are substantially the same as those used for the production of cider (see CIDER). It is generally stated by experienced makers that perry is more difficult to manage and handle than cider on account of erratic fermentation and a liability to cloudiness during storage. Many varieties undoubtedly require careful management for bottling purposes owing to the frequency and rapidity with which a thick crust is formed. This behaviour appears to be due to special characters of the pear tannins, and is sometimes turned to practical advantage in the 'fining' of ciders. It has been found that the addition of a small quantity of pear juice rich in tannin aids very considerably the natural clearing or 'fining' of certain types of cider during the later stages of fermentation.

When fit for consumption, perry is a pale straw- or, occasionally, amber-coloured liquor, containing in the case of dry perries about 5 to 6 per cent of alcohol and 1 to 2 per cent of sugar, and in that of sweet perries about 2 to 4 per cent of alcohol and 4 to 8 per cent of sugar.

The most common disorders to which it is liable are acetification, sickness or 'secondary' fermentation, ropiness, and persistent turbidity.

References to perry and perrymaking are to be found in most of the works and periodicals on cider, but the literature of the subject is very limited. [B. T. P. B.]

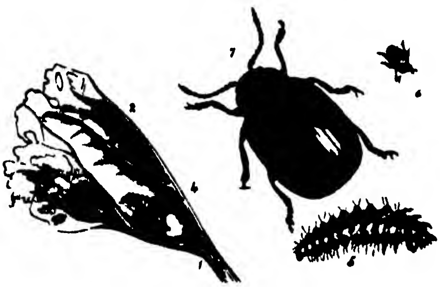
Peruvian Bark. See CINCHONA.

Peruvian Guano. See GUANOS.

Petrol Engines. See MOTORS, AGRICULTURAL.

Petunia, a genus of half-hardy annual or perennial herbs allied to Nicotiana (nat. ord. Solanaceæ). They have crimson, violet, white, or striped flowers, and are natives of Brazil and the Argentine. They are very showy and popular plants, being particularly well adapted for growing in vases, for massing in beds, and for planting under walls. As they are liable to be attacked by mildew when the cold nights set in, they should be given a sunny position in well-drained soil. The numerous garden varieties have been obtained from *P. nyctaginiflora* and *P. violacea.* The named varieties are propagated by cuttings obtained from plants preserved through the winter, and inserted in February or March, or from the beds in August, in a close frame. Very good results may, however, be obtained from plants raised from seeds sown in heat early in the year and planted out at the end of May. Petunias require plenty of water in summer, and it is well to insert stakes in the beds to keep them erect. [W. W.]

Phædon betulæ, the Mustard Beetle or 'Black Jack', is a small beetle of a metallic-



Phædon betulæ

1, Part of a turnip leaf, showing 2, the eggs 3 and 4, the grubs at different stages; 5, the grub, magnified, 6 and 7, the beetle, natural size and magnified.

blue-black colour which is sometimes exceedingly destructive to certain cruciferous crops, especially where, as in the case of the Mustard crops grown in the fen districts, proper rotation is not observed.

The beetles hibernate, often utilizing the chinks in fences, &c., for shelter, and in the spring the female lays her eggs on the leaves of the young plants. From these the first brood of grubs soon hatch out and devour the leaves. By midsummer these have attained maturity, and a second brood appears, which attacks the Mustard with disastrous effect. The insect is injurious both in the grub and the beetle stage. The measures which have often been advocated for keeping the beetle from a crop, *e.g.* the digging of trenches filled with tar, are of little or no use, as the beetle can fly well. Nor have any dressings, except of forcing manures, proved satisfactory. Tarring the fences in early spring kills some of the hibernating beetles; and any rubbish in which they are likely to be hiding should be removed and burnt. Tarred cloths dragged over the infested crops are useful in catching myriads of the beetles, and various devices for utilizing farm implements for this purpose have been used with good effect by Mustard growers. The proper treatment would naturally be an adequate system of rotation, so that cruciferous crops are only taken in the neighbourhood at intervals of some years; but when this is impracticable, either from want of agreement between neighbouring farmers or from the urgent need to grow Mustard annually, the best plan would be to regard the beetle as a pest certain to occur, and to prepare for it by establishing chickens, or better, ducklings, throughout the Mustard fields, erecting waterproof houses for their protection.

In these attacks various species of beetle are concerned, and are indiscriminately called 'Mustard beetles', but *Phædon betulæ* predominates. [C. W.]

Phalera (Pygæra) bucephala (the Buff-tip Moth) is frequently more or less injurious to a variety of trees, but particularly to lime and nut trees. The moth is a large and striking insect, easily recognized by the buff-coloured patches on the extremities of its fore wings; and the caterpillars, which attain 2 in. in length, are rather hairy, and variegated with yellow and black. They are gregarious, numbers of them being found feeding together. They turn to chrysalids under the soil, and clusters of them may be generally found at the base of an infested tree.

Treatment.—Shaking down the caterpillars; picking off and destroying leaves bearing a swarm of young caterpillars; destroying the chrysalids at the base of the trunk; spraying the tree with an arsenic spray while the caterpillars are feeding. [C. W.]

Pheasant (ord. Carinatæ; sub-ord. Galliformes: family, Phasianidæ).—The British Pheasant, upon the rearing, preservation, and shooting whereof such lavish expenditure is devoted, has become a blend of different species. The species originally introduced to Britain, probably by the Romans, certainly before the Norman Conquest, is that known as *Phasianus colchicus*, the name denoting its reputed origin on the river Phasis in Colchis (in the Caucasus region). This bird held the field undisputed till about the close of the 18th century, when the Chinese Ring-necked Pheasant (*P. torquatus*) was introduced, differing from the other bird in having a broad white collar round the neck, buff feathers forming a cap on the head, grey-blue upper wing coverts and rump feathers; besides which the ground colour of the spangled breast and sides is brassy or golden in hue, instead of rich copper as in the Colchic Pheasant. About the year 1840 a third species was added to the stock, the Japanese Pheasant (*P. versicolor*), of which nearly all the plumage is suffused with green lights, and deep-green takes the place of the mottled breast distinguishing the other two species. The hens of all three species closely resemble each other in their ashen and brown plumage; and as the Colchic, Chinese, and Japanese all interbreed freely, the hybrids

being fertile, the result has been that it is exceedingly difficult to find any pheasant of pure race in the United Kingdom. The Colchic bird still exists in out-of-the-way parts of western Scotland and Wales, where it is known among gamekeepers as 'the old black pheasant'; but the Chinese Ring-neck being more prolific, has impressed his stamp, the gleaming white collar, upon the general stock in these islands. Further confusion of blood is likely to result from the recent introduction from Afghanistan of the Prince of Wales's Pheasant (*P. principalis*), with white wing coverts and orange-red upper tail coverts; and of the Mongolian Pheasant (*P. Mongolicus*), the largest of all the true pheasants, with white wings, a broad white collar, and rich-red flank feathers.

Hybridization has gone on all the more rapidly and extensively owing to the almost universal practice of hand-rearing pheasants by hundreds and thousands for cover shooting. That form of sport has been completely altered in character in consequence. In former days, the guns used to walk through the woods with the beaters, taking the birds as they rose, the ground game as it bolted, a couple of guns being posted forward to intercept the fugitives. Nowadays, all guns are placed round the end of a cover for 'the rise', and the only form in which men care to shoot pheasants is when they fly far overhead. So far, the modern method is a great improvement on the older, for a pheasant in full flight at a height of 90 or 100 ft. offers a far more sporting target than the same bird rising out of tangled underwood. Unfortunately, the spirit of competition and record breaking, combined with the ease with which pheasants may be reared in almost any quantity, has tended to deprive cover shooting of all vestige of feral character; it has become a mere test of the host's liberality, his keeper's skill in rearing and showing the birds, and the marksmanship of his guests in killing them.

Probably nine-tenths of the pheasants shot in this country and of those exposed for sale in the towns, are birds of the first season, not more than six or seven months old, and there must be many people who have never seen the adult cock bird in the splendour of courtship, when his whole plumage acquires an indescribable lustre, his ear coverts rise into jaunty, horn-like prominences, and the bare, scarlet patch above the eye swells into a conspicuous comb.

The various species of pheasant enumerated above, having doubtless but recently diverged from a common ancestry, differ little, if at all, from each other in habits and food. The cock is polygamous, fighting fiercely with any rival who may approach his harem. At the end of April or beginning of May the hen scrapes a little hollow in the ground of a wood, in a hedgerow, or on the open moor, lines it scantily with grass and leaves, and lays therein from eight to twenty eggs. Unlike the grouse and partridge, if she is flushed from the nest when sitting, she seldom returns to it; and, when her brood is hatched, she is generally a careless mother, although instances occur of a hen pheasant going through the time-honoured performance of shamming cripple in order to draw away an intruder from her chicks.

It is now the universal practice of game preservers to feed their pheasants liberally in the covers where they are to be shot; which goes far to save neighbouring corn crops from damage. But where such crops border closely upon the preserve, the gamekeeper should be vigilant to prevent his hand-reared birds trampling the growing corn and feeding on the stooks. In some districts pheasants take to the fields, roosting on the ground and never or rarely entering a wood. Such birds eat immense quantities of small seeds, fruits, and insects, the damage they do being confined to the time when the ripe grain is on the ground. The food most commonly supplied in the covers is Indian corn, of which pheasants are insatiably fond, and on which they thrive very well; but it has this disadvantage, that it imparts a disagreeable yellow colour to the fat of the bird, and impairs the flavour of the flesh. Barley, oats, and potatoes too small for market make a desirable variety in the bill of fare. [H. M.]

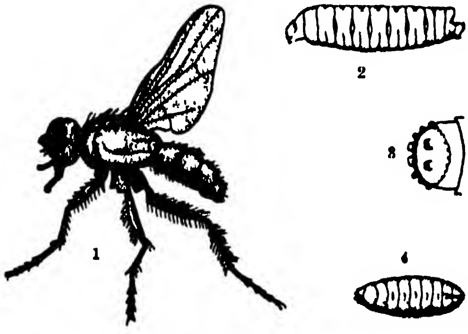
Phleum, a genus of grasses to which the well-known Timothy belongs. See TIMOTHY.

Phlox, a genus of chiefly hardy perennial plants (nat. ord. Polemoniaceæ) with showy white, violet, and red flowers, a few of the species being half-hardy annuals. They are natives of North America and Russian Asia. The perennial border phloxes are the outcome of a cross between *P. paniculata (decussata)* and *P. maculata*, and are popularly known as forms of *P. decussata*. There are a very large number of named sorts, varying from 1 ft. to 4 ft. high, with bright-coloured flowers, and recently considerable improvements have been effected in the early-flowering sorts. Phloxes will grow and flower anywhere, and it is customary to give them but little attention, but when afforded good cultivation the flowers are much finer. They should be grown by themselves, planted about 18 in. apart in beds of good soil, or in masses in the mixed border— not crowded up with all kinds of other plants. They should be replanted every three or four years. A mulch is very helpful to them as tending to prolong the flowering season, as also are heavy waterings in dry weather. The fungoid disease which attacks phloxes is best guarded against by a dressing of lime. They are usually propagated by cuttings procured from the bases of old plants in March and inserted in a slightly heated frame. If the plants produce too many stems it is a good plan to thin them, and as they are brittle early staking is advisable.

Phlox Drummondi is one of the best half-hardy annuals, being particularly useful for growing among taller plants. It is a native of Texas, growing 1 ft. in height, with variously coloured flowers produced in August. The seeds are sown in gentle heat in March, the seedlings being pricked off, their points pinched out when about 3 in. high, and grown on in cold frames until May. This plant is also grown in pots for greenhouse decoration, and it may be propagated by cuttings. [W. W.]

Phorbia brassicæ (Cabbage Fly) infests

the roots of cabbages and turnips when in the maggot state, and does great mischief. The cabbage roots become enlarged and brittle, often quite hollowed out, the maggots revelling in the cavities. They are very similar to those of the flesh flies, being fat, yellowish-white, tapering to the head, which has two black hooks; the blunt tail has two brown spiracles and some minute processes. Excepting in the depth of winter they may be found feeding all the year; heat, however, develops them most rapidly, for in May and June they exist at the same time as maggots, pupæ, and flies. The larvæ are transformed to bright rust-coloured horny puparia in the roots, or they bury themselves in the earth; these have a few tubercles at the head, and minute spines at the tail. They mostly appear to pass the winter in the pupa-



Cabbage root Fly (*Phorbia brassicæ*)

1, Male fly, greatly magnified; 2, maggot, magnified; 3, last section of maggot enlarged, showing tubercles; 4, puparium, magnified.

rium stage in the soil, but some do so in the cabbage stumps. The flies which hatch from them differ so much in the sexes that they do not look like the same species. The *male* is ashy-grey and very bristly; the eyes nearly meet on the crown, and the face is silvery-grey, with a long black streak on the forehead; the two antennæ are small, black, with a downy bristle; the trunk is grey, sides whitish, with three faint broken stripes down the back; body linear, shining-grey, with a black stripe along the centre; the edges of the segments are also black; two wings transparent, two balancers ochreous; legs black and spiny. *Female*, ashy-grey; face silvery-white, sides of trunk pale; eyes distant, with a broad black stripe between them, of a chestnut colour in front; the body is conical at the tip; the wings are ochreous at the base, nearly $\frac{1}{4}$ in. long, $\frac{1}{2}$ in. in expanse. They also burrow up the stems of young cabbage plants, and are even found in the ribs of the leaves. Attacked plants soon wilt, and in windy weather snap off close to the ground. The more often cabbages are grown on the same land the worse the attack becomes.

Treatment consists of placing tarred card disks around the young plants when set out; of dibbling in the plants with a handful of soot and lime; broadcasting soot and lime around the plants as soon as they are set. Cabbages must not be grown two years running on the same land or be followed by turnips where the maggot occurs. Land should be deeply trenched and dressed with gas lime after an attack, and all cabbage stumps burnt. [J. C.] [C. W.]

Phorodon humuli (the Hop Aphis or Hop Fly) is the well-known plant-louse of the hop. A few of the insects hibernate in the hop hills, but the attack is in the main the result of a migration from various trees of the plum tribe, especially the sloe and damson. This migration begins in May, and may last till July. The flies produce living young (known as 'nits' or 'lice') which develop into wingless females,

Ova of the Hop Aphis (*Phorodon humuli*) on Damson Shoot

also capable of producing living young. Several such generations take place, with the occasional occurrence of winged forms which spread the attack. When the hops are ripening off, almost all the 'flies' acquire wings and go back to the sloes and damsons, where presently a brood of both males and females is produced. These result in the deposit of 'winter eggs' round the buds, and from the lice which hatch out in the spring are developed the flies which migrate anew to the hops. Every hop-grower is familiar with this pest. The attack varies greatly in different years, and is most severe when the migration period is irregular and prolonged, and when the weather conditions are adverse to the rapid growth of the hops.

The *treatment* consists in washing the hops by means of hand-, horse-, or steam-driven sprayers. Numerous washes, more or less effective, are in the market, and they generally consist of soft-soap emulsions with which some insecticide is mixed. Soft soap and quassia, and soft soap and paraffin are favourite washes, but the former is much to be preferred. 6 lb. soft soap (Chiswick), 10 lb. quassia chips to 100 gal. of soft water applied at an early stage of the attack has the most satisfactory results. Paraffin emulsions are liable to do considerable harm to the bine.

The washing of orchard plum trees in the

neighbourhood of hop gardens is little practised, but the life-history of the pest indicates that such a measure would be likely to mitigate hop-fly attack. [C. W.]

Phosphates. See PHOSPHATIC MANURES and PHOSPHORUS COMPOUNDS IN SOIL.

Phosphatic Manures.—Of all the distinctively phosphatic manures, bones were the first to come into use. It is difficult to say when they began to be used; but it is certain that they were in use to a certain extent long before it was known that their value depended on the phosphate and nitrogen which they contain. Their use extended greatly in the early part of the 19th century, and won a well-established place in the favour of agriculturists. Bones and bone ash were both used in these early times. Bones, though they supply some nitrogen, are mainly a phosphatic manure, while bone ash is an entirely phosphatic manure. About the middle of the 19th century the industry in mineral phosphates became established. The use of these for the manufacture of superphosphate began about 1845, and the industry has ever since continued to grow in magnitude and importance. At present about five million tons of mineral phosphate are consumed annually in this industry.

The manufacture of dissolved or soluble phosphates began about the year 1840. Liebig made the suggestion that if bones were treated with sulphuric acid they could be rendered effective as manure without it being necessary to grind them finely. About the same time Lawes independently arrived at the same conclusion, and started the manufacture of dissolved manures, at first on a small scale for his own use, and afterwards in a factory at Deptford. At first only bones or bone ash were used, but Lawes soon began to use mineral phosphates.

Basic slag did not begin to be used as a manure till about 1885. Its use extended with great rapidity, and at present about two million tons are used annually.

There are some other minor phosphatic manures, such as precipitated phosphate and Wiborg phosphate, in use; but bones, mineral phosphates and the superphosphate manufactured from them, and basic slag are the largely used articles which, taken together, supply nearly all the phosphate used for agricultural purposes.

All the important phosphatic manures contain their phosphoric acid in combination with lime, that is, they contain phosphates of lime.

The phosphatic rocks used for the manufacture of manure contain, like bones, tribasic phosphate of lime, $Ca_3P_2O_8$, and have been derived from apatite. Some of them consist of masses of fossilized bones and teeth, others have been formed by the decay and consolidation of the mineral matter of guano, while others have been deposited from solution in water. In all of these the phosphate is not crystalline as in apatite, but amorphous. They contain various percentages of phosphate. The purest phosphatic rocks in use contain over 80 per cent of tribasic phosphate of lime, while a low-grade material such as Belgian phosphate may contain under 40 per cent. The phosphate is generally associated with a greater or less amount of carbonate of lime, and with siliceous matter, oxides of iron and aluminium, and other impurities. See MINERAL PHOSPHATES.

The tribasic phosphate of lime contained in the mineral phosphates and in bones is insoluble in water, and even when finely ground forms a slow-acting manure. A small amount of ground mineral phosphate is used directly as manure. Though it is slow-acting it is per unit of phosphate the cheapest phosphatic manure on the market. Much more of it might be used where a slow-acting manure is all that is wanted, *e.g.* for grasslands.

Nearly all the mineral phosphate is made into superphosphate before it is used as manure. This turns the insoluble tricalcium phosphate almost entirely into the soluble monobasic phosphate of lime or monocalcium phosphate, $CaH_4(PO_4)_2$, and phosphoric acid. (See SUPERPHOSPHATE.) As these are readily soluble in water the phosphate is washed into the soil and thoroughly distributed in solution, and so rendered more active and available for plants. This advantage has to be paid for in the greatly increased unit price of the phosphate. The soluble phosphate is soon reverted or rendered insoluble in the soil; this prevents it being washed out in the drainage, while it leaves it in a form readily available to plants.

Precipitated phosphate and basic superphosphate contain a phosphate intermediate between the insoluble tricalcium phosphate of mineral phosphates and bone ash and the soluble phosphate of superphosphate. This is dibasic phosphate of lime or dicalcium phosphate, $Ca_2H_2(PO_4)_2$. This phosphate is not soluble in pure water, but is readily dissolved by very dilute acid solutions, such as a solution of carbonic acid. It is therefore readily available to plants. On the other hand, manures containing it are, generally speaking, expensive per unit of phosphate.

In basic slag, also, the phosphate is combined with lime. It is a basic phosphate, and is usually represented as the tetrabasic phosphate of lime, or tetracalcium phosphate, $Ca_4P_2O_9$ or $Ca_3(PO_4)_2.CaO$. It is more probable, however, that the phosphate contained in basic slag is a complex double phosphate and silicate of lime. (See BASIC SLAG.) In any case, nearly the whole of the phosphate in basic slag, though not soluble in water, is, like dicalcium phosphate, easily soluble in weak acid solutions, such as a solution of carbonic acid or a dilute solution of citric acid. It is therefore readily available to plants, and forms a more active manure than ground mineral phosphates. In price per unit of phosphate it is intermediate between the insoluble phosphate of ground mineral phosphate and the soluble phosphate of superphosphate.

Iron and aluminium phosphates are found to a considerable extent in nature, but on account of their insolubility and want of availability to plants they are not made use of as manures.

In this country all phosphates are estimated as tricalcium phosphate, $Ca_3P_2O_8$. Even when a manure, such as superphosphate, really contains soluble monocalcium phosphate, the phosphate is calculated and stated in analyses and invoices as

if it were tricalcium phosphate. In all other countries phosphates are stated more scientifically and accurately as phosphoric acid, P_2O_5. This gives a smaller percentage, and the custom in this country of stating as tricalcium phosphate grew up as it gives a larger percentage, and so makes the manure look better. This method of stating phosphate is made the only legal one for manures by the Fertilizers and Feeding Stuffs Act. As 310 parts of tricalcium phosphate are equivalent to 142 parts of phosphoric acid, in order to convert percentages of phosphoric acid into percentages of tricalcium phosphate it is necessary to multiply by $\frac{310}{142}$, which is equal to 2·18. On the other hand, to convert tricalcium phosphate into phosphoric acid it is necessary to multiply by $\frac{142}{310} = 0{\cdot}46$.

[J. H.]

Phosphorus Compounds in Soil.—The phosphorus compounds in the soil fall into two groups: (1) mineral or inorganic; (2) organic.

Mineral Compounds: Phosphates.—The existence of phosphates in soil has been known for many years, and is recorded by Dundonald in 1795, and confirmed by later workers. They are found in small quantities in every soil, and in large amounts in certain regions usually associated with chalk or limestone formations.

(a) *The Phosphates Occurring in Large Deposits.*—These usually consist of calcium phosphates mixed with varying amounts of calcium carbonate, of iron and aluminium compounds, or of calcium fluoride. The discovery of these deposits made the production of superphosphates possible, and for this purpose they have been largely used. The first beds discovered were at Estremadura in Spain. In 1845 Henslow directed attention to the deposits of coprolites occurring below the chalk formation in Surrey, Cambridge, and the eastern counties. These deposits, however, are no longer of practical importance, having been supplanted by French and Belgian deposits. The most prolific mines are those of South Carolina, which supply two well-distinguished grades. One, called land phosphate, is obtained from the islands; the other, dredged from the beds of rivers, is known as river phosphate. The former contains some iron and aluminium oxides; the latter is much purer, and is therefore preferred by English manufacturers. Valuable deposits also occur in Florida and Tennessee. Of recent years the northern African beds, which are also nearly free from iron and aluminium, have become very important. Supplies also come from the Pacific islands, and deposits are known to occur in other parts of the world. The consumption is enormous, and is increasing. Phosphates may originally have been formed by the oxidation of phosphides in the igneous rocks, but the present-day deposits are of animal origin. Their formation is still going on in some parts of the Pacific islands. Guano deposited by the birds is mainly nitrogenous organic matter with a certain percentage of phosphate; exposure to the weather causes oxidation of the organic matter and disappearance of the nitrogen, leaving residues which react with the calcium carbonate in the rock beneath to form a calcium phosphate. The intermediate stages of this process, while a little nitrogen still remains, yield phosphatic guano; the final stages give a pure phosphate greatly valued for making superphosphates.

There are two other ways in which phosphatic deposits are supposed to have arisen. The true coprolites are the droppings of fish, reptiles, and mammals in a more or less fossilized condition, whilst the other phosphatic nodules may arise by the aggregation of phosphate deposited from solution round some centre; the result would be that phosphate previously disseminated through a mass of soil would become concentrated in a single layer. Crystals of apatite probably form in this way. Full accounts of phosphatic deposits are issued by the United States Geological Survey. The chief use of mineral phosphates is for making superphosphate, but all deposits are not equally suitable. For high-grade super. a mineral containing 70 per cent or more pure phosphate is preferred; for the ordinary 26-per-cent grade a poorer phosphate (50 per cent or more) can be employed. The presence of calcium carbonate is rather an advantage, since the calcium sulphate to which it gives rise absorbs water readily during the process of manufacture, and forms a dry porous mass easily broken down to a fine powder. Silicates are neither harmful nor beneficial, but the oxides of iron and aluminium are objected to by English makers because the resulting superphosphate tends to 'revert', *i.e.* some of the phosphoric acid or soluble phosphate reacts with the iron or aluminium sulphate, producing a phosphate insoluble in water, and consequently regarded as valueless by British analysts.

Mineral phosphates have also been used direct as manure without any treatment except fine grinding. Daubeny in 1845 made field trials with the Estremadura phosphates. Paine at Farnham showed that the phosphatic nodules in and below the chalk had considerable manurial value. Dehérain made pot experiments with similar deposits in France on soils from Brittany and the Landes, and found that *so long as lime was absent*, mineral phosphates were as useful as potassium phosphate. The experience of farmers in these districts also demonstrated the value of mineral phosphates on soils deficient in lime. This conclusion is borne out by recent pot experiments. Prianischnikoff finds that even in pure sand lupins can still utilize apatite, though Gramineæ fail to do so. Addition of ammonium sulphate, and to a much less extent of ammonium nitrate, greatly increased the availability of the mineral, while in an acid soil mineral phosphate was as good as any other.

Phosphatic guanos are well-recognized manures, and there is no fundamental distinction between these and the mineral phosphates. At the same time mineral phosphates differ considerably among themselves; and partly for this reason and partly because of the somewhat restricted range of soils and crops for which they are suitable, they have never been very popular, and are much more important to the manure manufacturer than to the farmer.

(b) ***The Phosphates Widely Distributed in Soils.*** —Besides calcium phosphate, iron and aluminium phosphates are also found in soil: the mineral *vivianite* is ferrous phosphate; and *angelite, fischerite, wavellite,* and *turquoise* are all forms of aluminium phosphate. Whilst it is easy to determine the total amount of phosphoric acid in the soil, it is not at present possible to show how it is distributed among the bases, and to indicate how much is calcium phosphate, how much iron phosphate, and so on. Attempts have been made to solve the problem by studying the solvent effect of weaker acids. Th. Schloesing, jun., treated soil with very dilute nitric acid, and found that up to a certain point the amount of phosphate dissolved varied with the concentration of the acid. Beyond this, a further addition of acid does not increase the amount in solution, and it is only when the concentration is considerably increased that the quantity of soluble phosphate is appreciably augmented. During the first stage the phosphates attacked appear to be those of calcium, magnesium, and the alkali metals, but not iron, of which only traces are found in solution. In the second stage the solution contains noticeable amounts of iron. Hall and Amos varied the experiment by extracting the same sample of soil five times in succession with fresh lots of 1-per-cent citric acid. They found a gradual falling off in the amount dissolved at each extraction, but finally a state is reached when small and fairly constant amounts are dissolved each time. The number of milligrams of phosphoric acid (P_2O_5) dissolved from 100 grams of soil were:—

Soil from—	Extractions					
	1st	2nd.	3rd.	4th.	5th	6th.
Broadbalk field, Plot 8	46·3	18·9	7·8	5·3	4·0	3·0
,, ,, ,, 10	7·7	5·2	3·3	2·7	2·7	2·7
Saxmundham .	7·2	5·8	5·3	4·1	3·1	2·1
Cockle Park	14·3	8·0	7·4	5·2	4·3	3·8
Bramford . ..	72·6	28·4	19·5	—	5·2	3·2

Broadbalk Plot 8 had received each year a complete manure, including super., whilst Plot 10 received nitrogenous manure only and no super. The other soils had been under ordinary farming.

The experiments are complicated by the reverse reaction that takes place between the dissolved phosphoric acid and certain constituents of the soil, resulting in the formation of new insoluble phosphates. It has not yet been possible to apply the newer methods of physical chemistry to the determination of the nature of the phosphates in soils. But it is possible to classify them provisionally on the following lines:—

1. Phosphates which were present in the original rock and have withstood the weathering agencies;
2. Phosphates deposited on clay, or other materials, from solution in water; or
3. Arising from the decomposition of plant or animal substances.

In general the first group would be very much less soluble in acids than the other two, but the line of demarcation is not sharp. The existence of the different groups of phosphates is well shown by the widely different amounts of phosphoric acid extracted by different solvents. Moore found that concentrated hydrochloric does not dissolve all the phosphoric acid as is usually supposed, but only about half: thus two sandy soils yielded respectively ·083 and ·089 per cent on breaking up with hydrofluoric acid, but only ·032 and ·035 on extracting in the usual way with hydrochloric acid; whilst two clay soils gave ·147 and ·275 after hydrofluoric acid treatment, but only yielded ·089 and ·185 per cent respectively to hydrochloric acid. Hall and Plymen obtained the results shown in table at foot of this page.

The easily soluble phosphates appear to be of most value as plant food. This was set forth clearly by Daubeny in 1845, and was again emphasized by Nilson in 1889. He and Eggertz found that a soil washed with 2-per-cent hydrochloric lost so much plant food that it would no longer grow barley. The phosphates left unattacked by acid of this strength were presumably of little value for the plant. It is now customary in soil analysis to attach more importance to the portion of phosphoric acid soluble in weak acid than to the total amount. No sharp line can be drawn between the easily soluble and the less easily soluble; a purely conventional method must be used, and the results interpreted by comparison with similar soils of known agricultural history. Each country has adopted its own method. In Great Britain 1-per-cent citric acid is used, as suggested by Dyer; in America $\frac{N}{200}$ hydrochloric is preferred; Dehérain in France suggested dilute acetic acid; and Nilson in Sweden used 2-per-cent hydrochloric acid. Each of these solvents, properly used, gives useful results, and the choice is largely a matter of convenience. The reasons for adopting 1-per-cent citric are given in the

Percentage of Phosphoric Acid (P_2O_5) dissolved from various Soils

	Strong Hydrochloric Acid.	Dilute Acids equivalent to 1-per-cent Citric Acid— Hydrochloric.	Citric.	Acetic.	Carbonic.
Broadbalk field, unmanured ...	0·114	0·0021	0·0080	0·0011	0·0005
,, ,, minerals only ...	0·228	0·0360	0·0510	0·0098	0·0058
,, ,, dung	0·209	0·0224	0·0477	0·0166	0·0095
Loam on chalk, Wye, Kent	0·152	0·0167	0·0240	0·0056	0·0014
Weald clay, Marden, Kent	0·104	0·0021	0·0029	0·0007	0·0017
Sand, Tunbridge Wells beds, Trant	0·110	0·0031	0·0082	0·0011	0·0023
Alluvial loam, Falcondale	0·118	0·00435	0·0133	0·0006	0·0011

art. Soil Analysis; but even if they were less cogent it would be undesirable to change now.

Quantity of Phosphoric Acid necessary to Fertility.—It is impossible to lay down any hard-and-fast rule as to how much phosphoric acid should be present. In general, however, there should be at least ·01 per cent, and in some cases a good deal more. Phosphoric acid favours root development and early maturity; it is therefore specially useful for swedes, barley, and potatoes, and, in certain climatic conditions, for most other crops. As a rule, phosphates are of less importance on sandy soils which are already early and favourable to root development, than on clay soils where the conditions are reversed; so that an amount which is sufficient in the one case would be quite insufficient in the other. Climatic conditions are also important: the greater the rainfall the greater the need of phosphates. Further, the higher the farming the more phosphate is wanted.

The Organic Phosphorus Compounds. — It has been shown that 1-per-cent citric acid dissolves much more phosphorus than any of the other acids, the reason being that it attacks organic, as well as mineral, phosphorus compounds. Some of the organic phosphorus compounds resemble humus in being soluble in alkalis and insoluble in acids, and can therefore be obtained by washing soil with hydrochloric and then extracting with ammonia. It is often considered that the phosphorus is in humo-phosphic combination, the chief evidence being that humus will withdraw phosphoric acid from the solution. Very little work has been done on these compounds. Nuclein has been found, and also small amounts of lecithin and phytin. Recent Japanese experiments have shown that lecithin is distinctly useful as plant food.

Large quantities of organic phosphorns compounds occur in peaty and moorland soils, but they are of little value as plant food. Thus the Swedish moorland soils contain 0·15 per cent of phosphorus (as P_2O_5), and the fen soils of the Isle of Ely contain 0·3 or 0·4 per cent soluble in hydrochloric acid and ·03 to ·077 soluble in 1-per-cent citric acid, yet all these soils give considerable returns for phosphatic manures. When these soils are burned a certain amount of calcium phosphate is formed, and there is a marked gain in fertility. [E. J. R.]

Phragmites communis (Common Reed) is an underground creeping marsh and water grass, distinguished from all our native grasses by the excessive stoutness (average ¾ in.) and the excessive height (over 6 ft.) of its reed straws. The underground shoots bore their way to the surface about the beginning of April; by the end of April the shoot is 16 in. high and three leaves have unrolled from the bud; by the middle of May the height is over 2 ft. and the leaves are four in number; by the middle of June the height is over 3 ft. and the leaves seven or eight in number. All through the summer new shoots are continually appearing, so that Common Reed with its large and numerous shoots is a most productive grass. The leafy shoot is easily recognized by the large leaf-blades, about 1 in. broad, provided with a crown of short white hairs instead of a membranous ligule at the junction with the sheath. This hair crown acts as a sieve preventing dust and spores from entering between the leaf-sheath and the stem (straw). The shoots have little utility as fodder, because the skin of the leaf is excessively glassy (siliceous, and the edges of the blade cut like a saw. Horses however, readily eat the tender tops of the shoots cut off for this purpose in the month of June.

The April shoots come into flower by the beginning of August, but the later shoots remain barren; indeed, all the shoots may remain barren unless the marshy soil is rich. The fully formed ear is a dense panicle about 1 ft. long, chocolate-coloured when young, but lighter brown when the silvery hairs of the spikelets have developed. The spikelet itself is hairy and glossy, over ½ in. long, and contains from three to five flowers, the lower of which are male and consequently barren. The seeds (grains) ripen in winter, and by January the ears are completely ripe.

From January on to March is the best time to cut the reeds (straws) for reed thatch. If the reeds are allowed to stand till they are dried up they become brittle and useless. For thatching buildings, Common Reed is more valuable than straw, since the strong reed thatch lasts longer (over sixty years if periodically cleaned from moss and other surface contamination). Where thatch is wanted, no plant is more profitable on wet and submerged land than Common Reed.

Propagation is easy and rapid—either cuttings or transplants may be set in April. The Reed may also be produced from seeds (grains) taken from ripe plants in January. The seed is embedded in a ball of earth, and the ball is planted in March or April.

For preventing the encroachment of large streams, and for reclaiming useless marsh or submerged land, no plant is more serviceable than Common Reed. Its scaly stems grow rapidly through the submerged ground, branch freely in all directions, and, like other water plants, produce numerous bunches of roots from the joints (nodes); water 6 ft. deep is no barrier to this growth. Because of these peculiarities, this plant has been much used for binding the earth on river banks. For fresh water it plays the same part as Sea Lyme Grass (*Elymus arenarius*) for sea water. [A. N. M'A.]

Phyllopertha horticola (the Garden Chafer, Bracken Clock, or Small Rose Chafer) is the smallest of the four commonly destructive Lamellicorn beetles of the Chafer tribe, the other three being the Cockchafer (*Melolontha vulgaris*), the Summer Chafer (*Rhizotrogus solstitialis*), and the Green Rose Chafer (*Cetonia aurata*). The head and thorax are dark-green and the wing cases bright-chestnut-coloured. It is the insect which is roughly imitated by the angler's artificial fly known in Wales as the 'Cockabundy' (Welsh, 'Coch-y-bondhu'). It appears in June, sometimes a little earlier, and attacks the leaves of various bushes and trees, especially roses and fruit trees. Its larva, which is much like a small cockchafer grub, probably only lives for a single year, and though it feeds on the roots of various

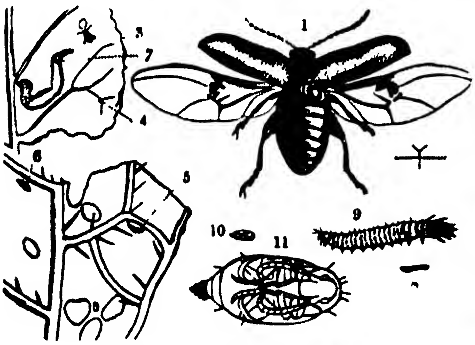
plants its depredations at this stage are seldom complained of. The beetles are comparatively torpid in the early morning and at dusk, and may be shaken down from the fruit trees into sheets at such times without making any serious attempt at escape by flight. The sheets may be rolled up, shaken over vessels containing hot

Phyllopertha horticola

1, Natural size; 2, magnified; 3, its larva.

water, and the scalded beetles fed to the fowls, which eat them greedily. Where the grubs are numerous in grassland or field crops there is little to be done except to encourage insectivorous birds. In the garden they may be baited for, as with the Green Rose Chafer (see CETONIA AURATA). [C. W.]

Phyllotreta nemorum. — The insects known as Turnip Fly or Flea usually comprise



Turnip Fly (*Phyllotreta nemorum*)

1, Phyllotreta nemorum (enlarged); 2 and 3, its natural size; 4 and 5, the eggs; 8 and 9, the grub; 10 and 11, the chrysalis, natural size and enlarged. The newly hatched grub is seen at 6, and its tunnel at 7.

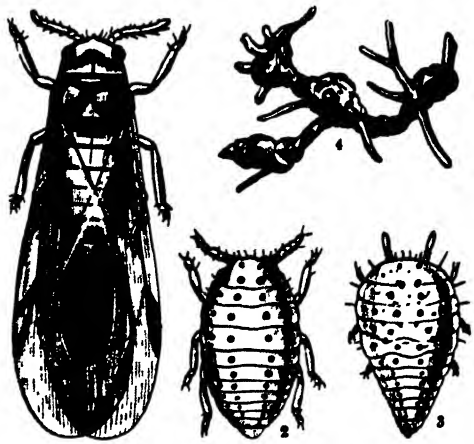
more than one species, but *Phyllotreta nemorum* is generally present in the greatest numbers. It is a minute beetle with a yellow stripe down each wing-cover, and with the thighs of its hind legs strongly developed, as in all the flea-beetles (see HALTICIDÆ), rendering them very effective leaping organs. This is the most familiar and destructive of turnip pests. It is particularly injurious to the plant in its earliest stages of growth, often necessitating a new sowing by entirely devouring the seed-leaves and destroying the crop. It will also perforate the rough leaves, but the effect is then less disastrous.

The beetles hibernate, and fly to the crop as soon as it appears above-ground. If the crop is not totally destroyed the eggs are laid on the under side of the rough leaf, and hatch in a week or ten days, when the grubs enter the leaf and feed on the inner tissues. In a week they are fully fed, and come out from the leaf generally near the midrib, and, falling to the ground, turn to pupæ or chrysalids, from which a second brood of beetles emerge in about a fortnight. There may be five or six broods in the season. In the absence of the turnip crop the beetle feeds upon cruciferous weeds, its chief food being Charlock.

Treatment.—The pest is most destructive in prolonged dry weather, when the progress of the crop is slow. It is advisable to retain all possible moisture in the soil by providing an early seedbed and disturbing it as little as may be at the time of sowing. Steeping the seeds in turpentine has some effect in keeping off the fly for a time, and every effort should be made to push on the crop as speedily as possible to the rough leaf. When the fly appears, it is customary to combat it by dusting the plants with soot and lime to render the leaves unattractive to the pest. With the same object, sheep are sometimes driven through the field, disturbing the beetles and scattering dust over the plants. A better plan is to distribute a spray of pure paraffin, at the rate of 1½ gal. an acre, by means of a Strawsonizer or other horse-spraying machine. It is especially important to suppress Charlock as far as possible on the land, and other cruciferous weeds such as Shepherd's Purse are calculated to encourage the fly.

Other species of Phyllotreta are *P. consobrina* (the Black Metallic Flea), common on chalky and light soils in the south and west of England; and *P. cruciferæ* (the Garden Flea), abundant in gardens on cabbage and radish. [J. C.] [C. W.]

Phylloxera vastatrix (the Vine Bug) is one of the most destructive of insect pests,



Vine Bug (*Phylloxera vastatrix*)

1, Winged female. 2, 3, Forms of larva (all greatly magnified). 4, Root galls.

and has at times threatened the vine-growing industry in various countries with extinction. The life-history of the insect is extremely com-

plicated, comprising in its cycle forms which feed upon the root and others which attack the leaves, covering them with little swellings or galls.

The wingless root form (*radicola*) is found with its proboscis fixed in the root tissues in March. It lays thirty or forty eggs, which in a week or two hatch into young lice, which quickly mature and lay similar clusters of eggs parthenogenetically, *i.e.* without the co-operation of any male insect. Numerous similar generations follow, so that it has been computed that a single insect in March may give rise to 25 millions in October. Some of the later broods develop wings and come above-ground, spreading the attack. These winged females lay two kinds of eggs—large, hatching into females, and small, giving rise to males. The life of the male is very brief, but the female, after being fertilized, lays a single egg (the 'winter egg') in some crevice of the bark of the vine. This gives rise, in the spring, to a 'stock-mother', which seeks the developing buds, the irritation of her sucking causing a gall on the leaf she attacks. Her eggs hatch into gall-inhabiting forms (*gallicolæ*), of which again there are several parthenogenetic generations, the last broods going below-ground and becoming *radicolæ*, and thus completing the life-cycle, which may be shown as follows:—

Wingless root-feeding female (*Radicola*)

Wingless root-feeding female—2nd generation

Wingless root-feeding female—3rd generation, &c.

Winged female

Large egg | Small egg

Wingless female | Male

Winter egg

Stock-mother

Leaf-feeding female (*Gallicola*)

Leaf-feeding female—2nd generation

Leaf-feeding female—3rd generation

Wingless root-feeding female.

Treatment.—The Phylloxera has been combated most energetically and with the greatest success in France. A multitude of measures have been adopted, of which the following are the principal:—

1. Submersion.—This is an excellent remedy where practicable, and a vineyard which can be kept under water for a month in autumn (September to October) is freed from lice. A longer submersion, six or seven weeks, is necessary in winter.

2. Injecting carbon-bisulphide into the soil to kill the *radicolæ*. Various instruments have been devised for this operation.

3. Painting the stocks with various insecticides to destroy the winter eggs. Vines of more than five or six years old must have the rough bark removed for this operation to be successful.

4. The use of American stocks, which are largely resistent to the attacks of Phylloxera. This measure has been adopted very extensively and with great success. [C. W.]

Physiology of Farm Animals.—Physiology is that branch of science which is concerned with the functions performed by the various organs or parts of living things. It is a department of biology, or the science of life. But just as biology is divisible into botany, which deals with plants, and zoology, which treats of animals, so also there is a plant physiology and an animal physiology, and it is the latter of these which forms the basis of medical and veterinary knowledge. Physiology must always be studied in close relation to anatomy or morphology (*i.e.* the department of biology which deals with form and structure), since it is impossible to have an intelligent comprehension of the parts of which an organism is built up without acquiring an insight into the functions which these parts respectively perform; and conversely, it is useless to attempt to understand rightly the functions of an organ without possessing a knowledge of its structure and composition.

The active living basis of all organisms, whether vegetable or animal, is called protoplasm. The vital substance forming the most highly developed animals differs in degree rather than in kind from the undifferentiated protoplasmic mass composing such a lowly type as the amœba. Protoplasm is composed of about 75 per cent of solid substances and 25 per cent of water. The solids consist mainly of a series of closely allied bodies called proteins which contain the elements carbon, hydrogen, oxygen, nitrogen, and sulphur; but certain inorganic salts are present in the ash when protoplasm is burnt, and these indicate the presence of potassium, phosphorus, and calcium in addition. Small quantities of fats and carbohydrates are also usually present.

An elementary knowledge of the physiology of protoplasm may be gained by studying the vital manifestations of the amœba. This is a minute organism found in stagnant water, and resembling, when seen under the microscope, a little lump of moving jelly. It can be observed to move about spontaneously, to eat up little particles of food, to excrete or get rid of waste products, to grow in size, and lastly, at a certain stage in its life-history, to reproduce by undergoing a process of simple division into two. In order to perform these functions it is essential that it should receive a supply of energy, in just the same way as a steam engine cannot be made to work unless it is provided with motive power. In the latter case this is supplied by the fuel, which undergoes combustion and so liberates heat. So also in the case of the animal the energy is derived from the complex food material, which undergoes a process of slow oxidation, thereby breaking down into simpler substances and setting free the

energy necessary for the discharge of the vital functions (see art. NUTRITION). The changes which the food or its constituents undergo in the amœba or any other organism are classed together under the term 'metabolism': those of them which relate to the building up of the food into the material of the body are referred to as 'anabolic' or 'assimilative'; while the changes which are associated with activity, resulting from a breaking down of complex substances into more simple ones, are known as 'katabolic' or 'dissimilative'.

An amœba consists of a single cell, that is to say, a minute mass of protoplasm containing within it a certain specialized portion known as the nucleus. There are many other unicellular organisms, varying in form but all resembling the amœba in their general plan. Higher in the scale we find groups of amœba-like cells aggregated together with little or no division of function. Such an arrangement occurs in the simpler kinds of sponges. But in the majority of multicellular animals whole groups of cells are separated off to subserve particular functions; and these form the various tissues. The body of a higher animal is, however, derived from a single cell essentially similar to that of an amœba, and this, in the process of individual development, undergoes a long series of divisions, the products of which become gradually specialized to form the different tissues—bone, cartilage, muscle, nerve, connective tissue, &c. Thus the outer layer of cells becomes adapted for protection and for feeling the impressions produced by changes in the surroundings; the inner layer lining the gut becomes fitted for the digestion and assimilation of food; while between these there are developed the skeleton and general framework of the body, and all the other tissues which assist in performing the vital functions.

These functions may now be considered more closely. The parts concerned with each function are usually called systems, and the subsidiary parts which compose these systems are known as organs. The following are the principal systems of the body in a higher animal: (1) The digestive system; (2) the circulatory system; (3) the respiratory system; (4) the excretory system; (5) the muscular system; (6) the nervous system; and (7) the reproductive system. In addition to these are the various organs of internal secretion.

DIGESTIVE SYSTEM.—In such lowly forms of life as the amœba, food is taken in at any point on the surface, and is then assimilated, the indigestible residue being cast out at some other part of the surface. But in Man and all the higher animals there is a differentiation of function, food being taken in only at a definitely located mouth, whence it passes down an alimentary canal which is divided into several portions. In some of these the digestible material is absorbed, passing through the wall of the canal and into the neighbouring blood-vessels, whence it is distributed throughout the body. The indigestible residue is expelled at a definite anus, which is placed at the hind end of the body.

In the mouth the food undergoes mastication by the teeth and is simultaneously acted upon by the saliva, in which there is a ferment, ptyalin, that has the power of converting indigestible starches into digestible sugars. The food next passes down the œsophagus or gullet into the stomach, where it is acted upon by the gastric juice. This contains two ferments—pepsin, which converts the nitrogenous constituents known as proteins into soluble substances of simpler composition called peptones; and rennin, which assists in the digestion of milk. It also contains hydrochloric acid, which helps in the process of digestion, that is to say, in reducing the food to such a condition that it can be assimilated. This gastric juice, like the saliva, is secreted in little tubular depressions, which, however, differ from those of the mouth in being distributed over the entire surface of the stomach instead of being limited to certain definite glandular masses. On passing out of the

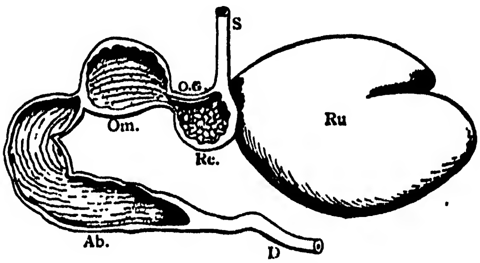


Fig 1.—Stomachs of Ox

S, Œsophagus. O.G, Œsophageal groove. *Ru*, Rumen or paunch *Re*, Reticulum or king's hood or honeycomb. *Om*, Omasum, manyplies, or psalterium. *Ab*, Abomasum, reed, rennet, or true digestive stomach. (The last three stomachs dissected to show their internal structure.) D, Duodenum.

stomach the half-digested food is forced into the beginning of the small intestine. Opening into this are two large glands, the liver and the pancreas or sweetbread. The liver secretes the bile, which is an alkaline fluid and has the power of dissolving fatty acids so that they are rendered capable of passing through the walls of the small intestine and being absorbed into the blood. The pancreatic juice contains at least three ferments—amylopsin, which like ptyalin converts starches into sugars; steapsin, which splits up fats into fatty acids and glycerin (the former being dissolved by the bile as just mentioned); and trypsin, which resembles pepsin in its action on proteins, but differs from it in being more potent, since it can break down these complex substances not merely into peptones but into still simpler compounds known as amido-acids. The small intestine is provided further with a large number of smaller glands (Brünner's glands and Lieberkühn's crypts) which supply secretions containing other ferments, which act chiefly on the various sugars. Absorption goes on simultaneously with digestion, so that a large proportion of the digestible food material passes into the body through the wall of the alimentary canal in this region. The large intestine, which follows, is generally twice

as wide as the small intestine, but the size varies in the different animals. Here the surface is likewise covered with tubular glands, but absorption probably dominates over digestion. The last part of the large intestine—the rectum—opens to the exterior at the anus, where the fæces are expelled.

The above account of the digestive processes is applicable to nearly all the higher animals (mammals), but there are, of course, many variations in the different species. Thus, in ruminants (cows, sheep, goats, &c.) the stomach is complex, being divided into four divisions, but only the last of these (the abomasum) acts as a true digestive stomach. In the other three the food undergoes churning or trituration, and from the first of these is transferred again to the mouth to be further masticated in the process of chewing the cud. In the horse, pig, and dog, as in Man, the stomach is simple, consisting of one compartment. In the horse it is noticeable that the

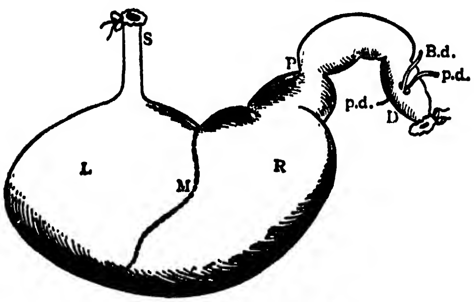


Fig. 2.—Stomach of Horse

S, Œsophagus. L, Left, cardiac portion with cuticular mucous lining. R, Right, pyloric portion with villous mucous lining. M, Dotted line, marking line of separation of left and right portions. P, Pyloric ring. D, Duodenum into which are seen entering the *Bd*, bile duct, and *Pd*, *Pd*, the two pancreatic ducts.

saliva contains practically no ptyalin. The alimentary system of the same animal is, however, chiefly remarkable for the enormous size of the first part of the large intestine (the colon), which is largely used as an organ for digesting the cellulose of the food. In many animals, and especially in herbivorous ones, there is a very large cæcum, that is, a part of the gut which ends blindly and which is given off at a point where the large and small intestines meet. This is used largely as a storehouse for fluids. In flesh eaters (dogs, cats, &c.) the cæcum is relatively small and functionless, as it is in Man.

Circulatory System.—To enable the food which is absorbed from the alimentary canal to be distributed to all the organs of the body a circulatory medium is provided, and this medium is the blood. In all the higher animals the blood is kept in motion by a central organ of propulsion, the heart. In a mammal the heart is divided into four chambers—a right and a left auricle, and a right and a left ventricle. Each chamber communicates with the adjoining ones by valves, which only permit of the blood passing in one direction. The circulation is maintained by the heart alternately contracting and dilating, the compressing force being supplied by the muscular wall of the organ. The heart communicates with an elaborate system of vessels, those which carry the blood away from it being called arteries, while those which bring the blood back are termed veins. The arteries possess thicker and more elastic walls than the veins. The arteries become divided up in the peripheral parts of the body

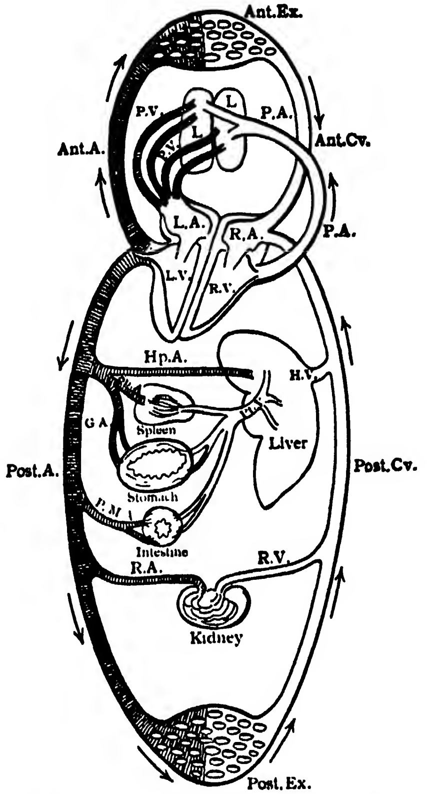


Fig 3.—Diagram of the Course of Circulation (Horse)

L A, Left auricle. L V, Left ventricle. R A, Right auricle. R V, Right ventricle. P A, Pulmonary artery. P V, P V, Pulmonary veins. L L, Lungs. *Ant. A*, Anterior aorta, and *Ant. Vc*, Anterior vena cava, go to form the blood supply to head and the anterior limbs, *Ant. Ex.* *Pst. A*, Posterior aorta, and *Pst. V.C*, Posterior vena cava form the blood supply to posterior part of body and limbs, *Post. Ex.* *Hp. A*, Hepatic artery. *Sp. A*, Splenic artery. G A, Gastric artery. P M A, Posterior mesenteric artery. R A, Renal artery. *Pt. V*, Portal vein conveying blood from spleen, stomach, and intestine to the liver. H V, Hepatic vein. R A, Renal vein. The vessels conveying arterial blood are cross lined. The arrows indicate the direction of the blood current.

into a number of much smaller vessels which permeate all the tissues, bathing the cells with blood—the capillaries. They unite again to form the veins, which transport the blood from the capillaries and back to the heart. If the web of a living frog's foot be examined under the microscope, the circulation of the blood in the capillaries may be observed quite easily.

The red colour of blood is due to the presence of innumerable little red disks known as corpuscles, which float in a yellowish-coloured semi-

transparent fluid, the blood plasma. In addition to these red corpuscles, blood also contains a relatively small number of white corpuscles or leucocytes, which have the power of independent movement and resemble the unicellular amœbæ referred to above. Their chief function is to eat up and so destroy the germs of disease. See art. BLOOD.

RESPIRATORY SYSTEM.—In order to keep an animal alive it is necessary to supply it with oxygen, for, as we have seen, every animal is dependent for its source of energy upon the

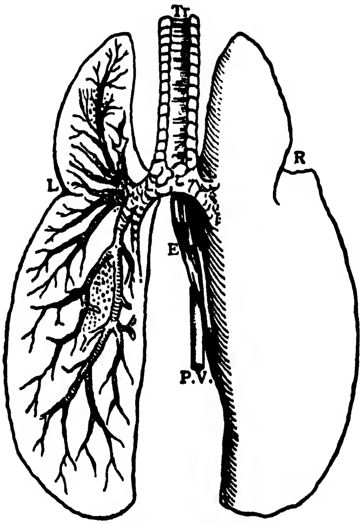


Fig 4.—Lungs of Horse

Tr, Trachea. R, Right lung. L, Left lung dissected to show ramifications of bronchi. E, Extra lobe on right lung, under which is seen passing PV posterior vena cava.

slow oxidation of the material which it builds up out of its food supply. As a result of this oxidation process it is continually giving off carbon dioxide. In the higher vertebrates the organs which are concerned in this gaseous exchange are the lungs; but in the lower forms of life the entire surfaces of the body serve to effect the interchange of oxygen and carbon dioxide; while in many other animals, which live in water (*e.g.* fishes), the respiratory organs take the form of gills.

The lungs of an animal are connected with the exterior by the windpipe or trachea, which opens into the back of the mouth at the root of the tongue. This tube at its lower end divides into the two bronchi, and these subdivide again and again within the lungs like the branches of a tree. Their finest divisions widen out into air cells which are in close relation to a meshwork of capillaries, the air in the air cells and the blood in the vessels being separated from one another by only a very thin layer of protoplasm. These air cells and capillaries form an essential part of the structure of the lungs. Here the gaseous exchange is effected, the blood corpuscles taking up oxygen from the air cells and giving off carbon dioxide. When the blood passes to the tissues this process is reversed, the carbon dioxide being taken up from the tissue cells, while oxygen is given off to these cells. Thus arterial blood, or blood which is being circulated to the tissues after having been to the lungs and heart, is bright-red in colour owing to the presence of a compound called oxyhæmoglobin, which contains oxygen in loose combination; whereas venous blood which is in process of being returned to the heart and lungs is purple, the oxyhæmoglobin having been reduced, in part at least, to hæmoglobin, thereby causing a change in the colour of the corpuscles. The complete course of the circulation in a mammal is as follows: Right auricle of heart, right ventricle, pulmonary arteries, lungs, pulmonary veins, left auricle, left ventricle, arteries (excepting pulmonary arteries), capillaries, veins (excepting pulmonary veins), and so back to the heart.

The interchange of gases which takes place between the lungs and the external air is effected by the alternate expansion and contraction of the chest wall, the air passing through the windpipe in opposite directions in the acts of inspiration and expiration respectively. In this way the excess of carbon dioxide in the lungs is got rid of, and a supply of oxygen from the external air is able to take its place. See art. RESPIRATION.

EXCRETORY SYSTEM—We have seen that the protoplasm of which an animal is composed consists principally of the five elements carbon, hydrogen, oxygen, nitrogen, and sulphur. As a result of katabolism these elements must be got rid of. The waste carbon is disposed of by the lungs in the form of carbon dioxide as just described, and a certain amount of oxygen is got rid of similarly. The hydrogen and a further proportion of oxygen is excreted in the form of water vapour both through the lungs and the skin. The waste nitrogen, however, and also the waste sulphur (but this is only a small quantity, since sulphur is very slightly represented in protoplasm) are got rid of by the kidneys, which are commonly described as excretory organs. For just as the cells of the body discharge their waste carbonaceous products into the blood, so also do they dispose of their nitrogenous products, and these are carried to the kidneys. In the latter the blood capillaries are separated by only a single cellular layer from the cavity which communicates with the exterior. The cells of this layer absorb the waste products and excrete them into the kidney tubules, together with water and some salts in solution. These form the urine, which flows down a duct termed the ureter into the bladder, from which it is expelled at intervals to the exterior in the act of micturition.

The nitrogen in the urine is present mostly in the form of urea and uric acid. In herbivorous animals the uric acid is either absent, or present only in very small quantities, its place being taken by hippuric acid, which is especially characteristic of the urine of the horse; but if the animals are fed on forage, no hippuric acid makes its appearance in the urine. Uric acid occurs more particularly in the urine of flesh eaters. Speaking generally, the quantity of nitrogen

excreted varies directly with the amount of protein contained in the food. See art. NUTRITION IN ANIMALS.

MUSCULAR SYSTEM.—A muscle is an especially contractile organ which is either circular (as in *sphincter muscles*) or straight. The latter is the more usual form among the higher animals. Such a muscle, upon contracting, reduces the length between its two farthest points. One of these points is usually called the origin of the muscle and the other its insertion. The muscles are attached to bones, and these by their movements may become inclined to one another at various angles. In the case of the limbs these angles are opened and closed, thereby causing progression, and the mechanical aid which is introduced to effect this is that of the lever. The muscles themselves are fleshy masses composed of fibres. Those movements which require to be quickly and forcibly carried out are performed by striated muscles, and since in most cases they are under the direct control of the will they are often called voluntary muscles; on the other hand, the sheets or closed tubes surrounding such organs as the intestines are formed of unstriated muscles, which are often termed involuntary. The muscles of the heart are intermediate in structure between these two kinds. The voluntary muscles form a considerable part of the body, and constitute the flesh or meat on an animal. Broadly speaking, the muscular system is that part of the body in which the energy set free by the oxidation of the food material is converted into motion and so carries on work.

NERVOUS SYSTEM.—In the lowest forms of animal life the protoplasm is uniformly irritable and contractile; but in the higher types, as just shown, the organs of movement are concentrated in a motor or muscular system, while there are also definite organs of sense (eye, ear, &c.). Such division of labour necessitates a means of communication between the various organs, and this function is fulfilled by the nervous system. The nerves consist of strands of a peculiar kind of tissue constituting the nerve fibres, and these connect together the sense organs and muscles and all the various parts of the body. The nervous system is presided over by the brain and spinal cord. The former of these is contained within the skull, while the latter consists of a hollow tube enclosed by the backbone or vertebral column. The brain and spinal cord together constitute the central nervous system. The other nerves are differentiated into afferent (sometimes called sensory) nerves, in which the impulses pass from the sense organs to the central nervous system, and efferent nerves (sometimes called motor), in which the impulses travel outwards from the central nervous system to the muscles or other organs to which a message is to be sent. All actions which are under the control of the will are presided over by the brain, from which the voluntary nervous impulses are transmitted. But there is another class of actions in which either the brain or spinal cord is concerned, but which are involuntary. These are called reflex actions. For example, if a frog after being deprived of its brain be hung up by its jaw and one of the toes pinched, its leg is drawn up. Such an act is involuntary, and in this case is controlled by that part of the central nervous system which is still intact, namely the spinal cord. If this be destroyed the reflex action can no longer take place. It is clear, therefore, that such an act involves a succession of processes, which are as follows. The pinching of the toe supplies a stimulus which is transmitted as a nerve impulse by an afferent nerve to the spinal cord. Another nerve impulse is then transmitted by an efferent nerve in the opposite direction, passing from the spinal cord to the muscles of the limb, and this causes them to contract. There are also cerebral reflexes, which are likewise involuntary. For example, the secretion of the saliva and the secretion of the gastric juice are reflexes which are induced by the introduction of food into the mouth, messages being transmitted in the first place in an afferent direction from the mouth to the brain, and then in an efferent direction from the brain to the secretory glands of the mouth and stomach. It is interesting to note that different sets of nerves are concerned in transmitting the impulses in opposite directions. In the body of a higher animal a close succession of reflex actions is continually going on, and it is in this way that the individual organism is able to react to environmental changes, and so to fit itself to its surroundings.

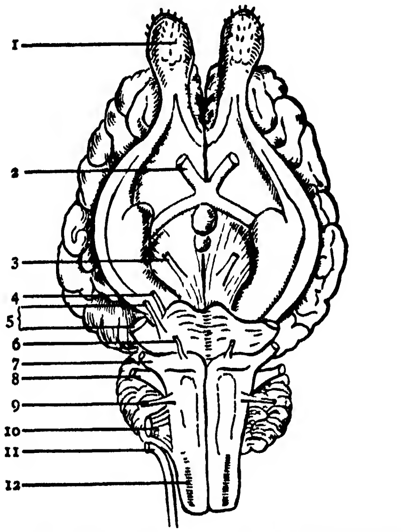


Fig. 5.—Base of Brain of Horse showing the Cranial Nerves

1, Olfactory. 2, Optic. 3, Oculo-motor. 4, Pathetic or Trochlear. 5, Trifacial. 6, Abducens. 7, Facial. 8, Auditory 9, Glosso-pharyngeal. 10, Pneumogastric. 11, Spinal accessory. 12, Great hypoglossal.

REPRODUCTIVE SYSTEM.—In the unicellular organisms like the amœba, reproduction is carried on by simple cell division. In the higher animals, however, there are certain special cells set apart for reproduction, the ova in the female and the spermatozoa in the male. The ova and spermatozoa are produced respectively in the ovaries

and testicles. Their function is to unite together, a single ovum fusing with a single spermatozoon and giving rise to a conjugated cell or oosperm, which by a long succession of cell divisions develops into a new individual. See art. REPRODUCTION.

ORGANS OF INTERNAL SECRETION.—In addition to the various systems described above, we find also certain organs that have the power of altering the composition of the blood by secreting into it chemical substances which are elaborated for the advantage of other parts of the body, whence they are conveyed in the blood stream. Many of the organs referred to above which subserve the functions already mentioned are in addition internally secreting glands, thus fulfilling more than one purpose. Such organs are the liver, the pancreas, the ovary, and the testicle. The liver, besides secreting bile, stores up a supply of carbohydrate in the form of glycogen, and when required liberates it into the blood as sugar. The pancreas also in some unknown way controls the carbohydrate metabolism, since after its removal experimentally sugar makes its appearance in the urine, thereby indicating an excess of sugar in the blood. The effects of extirpating the testicles (*i.e.* castration) in modifying the conformation and arresting the development of the male characters are well known. In a similar way the ovaries exert an influence over the female. But there are certain other organs, which appear to be solely organs of internal secretion. Such are the suprarenal bodies, which are situated just in front of the kidneys, one on either side. These secrete into the blood a substance known as adrenalin, which acts on the muscles and improves their tone. If these organs are removed extreme weakness, associated with muscular collapse, results, and is followed sooner or later by death.

[F. H. A. M.]

Pickling and Pickling Solutions.—The art of pickling of meats of various kinds is a very ancient one, and consists in saturating the tissues of meat with a solution of salt to which certain flavouring matters and a preservative have been added. The action which takes place is that the pickling solution displaces a certain proportion of meat juices, and to that extent the meat is rendered poorer from a dietetic point of view. Notwithstanding this fact, however, there is an ever-increasing demand for pickled products; thus rounds of beef or other portions are very commonly pickled and sold as 'beef hams'. Then also, tongues both of bullocks and pigs are pickled. The carcasses of pigs, either in sides or in sections, are pickled more commonly than any other animal product. The pickling solution used in all these various operations is very simple and of constant composition. Certain rules must be observed if success is to be attained in the use of pickle. First of all, whatever meats are intended to be pickled should be perfectly fresh, and should be hung in a cool, dry place until their temperature is about 55° F. It is quite possible to pickle meats at a higher temperature, but there is always a greater risk. The pickling room should be a cool, dark place, and should be kept scrupulously

Fig. 1.—Oak Tub for Pickling of Meats

It is fitted with a lid, but is also supplied with a perforated lid which fits inside, and upon which weights can be put so as to keep the meat down below the level of the pickle.

clean. The receptacles for pickling can either be of slate, cement, or oak tubs.

The other appliances are simple in character.

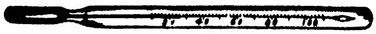


Fig. 2.—Meat-testing Thermometer

In connection with the pickling of meat on the farm it is desirable that the temperature of the meat should not be higher than 55° F., and this is ascertained by inserting the meat-testing thermometer into the muscles of the meat.

First of all, it is desirable to have a small cylindrical thermometer, so graduated as to conveniently record the temperature of the meat done, simply by inserting the thermometer into the muscles.

It will be necessary also to have an instrument for testing the density of the pickle. What is wanted is a saturated solution of salt, and the point of saturation should be accurately determined by means of a specially graduated hydrometer, called a salinometer. It is so graduated that the point of saturation is 100°; and, of course, if the salinometer shows a lesser degree than that, it is obvious that the point of saturation hasn't been reached.

Fig. 3.—Douglas's Salinometer

which is specially graduated for the purposes of pickle making, and the point of saturation of pickle is given as 100°

Another necessary appliance is the pickle pump. One form is merely a syringe, and can be used for very small operations; another is of a somewhat larger size, and is really a force pump, which enables the pickle to be forced into the meat at a high pressure.

Both of these appliances are used for the injection of pickle under pressure into the tissues of the meat, so that the curing effect may proceed at once, and any tendency to putrefaction which may exist in the meat, and which might develop in the interval before the pickle would under ordinary circumstances soak into the centre of the tissues of the meat, may be prevented.

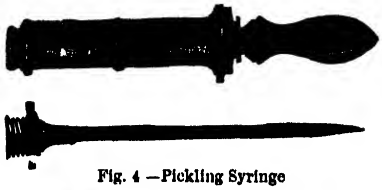


Fig. 4 —Pickling Syringe

Fig. 5 —Pickle Pump

Both of these appliances are for the same purpose, *i.e.* the injection under pressure of the pickle into the tissues of the meat.

Having obtained the appliances suitable to the size of the pickling operations contemplated, it is necessary then to prepare the pickle. This is done by taking the following materials:—

55 lb. salt,	5 lb. saltpetre,
10 lb. cane sugar,	5 lb. dry antiseptic (boron preservative).

Make this material *up to* 20 gal. with water, that is to say that the *total bulk* of the material is to be 20 gal. Stir all together for some time, after which, place the mixture in a boiling copper, and boil so long as a scum rises to the surface. Skim this off until the solution becomes fairly clear, and then withdraw the fire and allow the pickle to settle. This settling can be done anywhere else, either in a barrel or similar receptacle, should the copper be required; but, in any case, when the settling has taken place and the liquid has reached the same temperature as the surrounding atmosphere, it is then decanted off, or very carefully baled out into a pickling vat or vats, taking care not to transfer any of the sediment which will have settled out. The pickle is then ready for use, and will indicate from 95° to 98° on the salinometer, and while at such a degree it will be of the correct density.

It must be observed that successful pickling can only be carried on when the temperature of the pickling room and pickle are similar, and when such temperature is fairly low. In large pickling places it is usual to maintain the temperature during the pickling operations at 42° F., but on the farm such a temperature is quite unattainable, and anything between 50° and 60° F. is the general rule. In so far as the quantity of pickle is concerned, 20 gal. has been taken as being a convenient unit to work upon; but of course any other quantity can be made by multiplying or dividing by the same figure throughout. Many people prefer a certain piquancy in pickled meats, and this is arrived at by the addition of a cotton bag containing a mixture of—

½ lb. juniper berries,	½ lb. coriander seeds,
½ lb. bay leaves,	½ lb. Jamaica lump ginger.

All these ingredients in their whole condition are mingled together and placed in the cotton bag, which is then tied up and allowed to float on the top of the pickle, being occasionally drawn through it, so that the extraction, which is made very slowly, is uniformly mixed throughout.

In the pickling of meats a certain amount of judgment is necessary; for the larger the bulk the greater the time necessary to complete the pickling. A very good rule to follow, however, is, that in meats that weigh over 10 lb. in weight a mild cure is obtained by allowing one day in pickle for each pound in the weights of the meats. Mild-cured meats, however, must be consumed a few days after they have been taken out of pickle. For a cure which will ensure the products keeping safely for many months, two days in pickle for each pound in weight must be allowed.

Pigs' tongues, feet, and small pieces are cured sufficiently by immersing them in the pickle for from three to four days. Ox tongues can also be mild-cured in the same time; but it is usual to inject some pickle down each side of the tongue, through the main arteries which are found there, and which can be cut so as to enable the pickle needle to be inserted. The pickle can thus be injected into the centre and down the full length of the tongue at once.

Hams weighing 15 lb. can be mild-cured in fifteen days; hard-cured hams (for keeping a length of time) are cured in thirty days; and heavily salt-cured hams (in which condition they can be kept for over a year) in forty-two days.

Rounds of beef can be mild-cured in about fourteen days; but if they are for long keeping, the period must be prolonged in proportion.

In taking meats out of pickle they should be hung up, so as to drain; this should be done in a dark, cool place. When the pickle ceases to drip from the meats, they are then taken out and further dried by hanging up in a kitchen or dry loft.

Should it be desired to keep any of the meats for a prolonged period, it would be desirable, after the drying has taken place, to cover them up in cotton bags so as to prevent them from being struck by flies.

It is in this condition of dryness also that meats can be smoked. This is done by means of hardwood sawdust, which is allowed to smoulder away in some confined space, and the meats hung for at least three days in the smoke. In so far as the preserving of the pickling solution is concerned, it is important to

remember that with constant usage the pickle becomes foul, owing to the addition of the meat juices, which exude from the meat in the process of curing. In the small way it is desirable to get rid of the foul pickle altogether, but where the facilities exist it is possible also to utilize the pickle again by reboiling it. The boiling coagulates the organic products present, they settle out at the bottom of the boiling pan, and the clear solution is then decanted off, or baled out, as in the case of making fresh pickle. In treating pickle in this way, however, it is necessary to see that it is fortified with salt and the other ingredients already mentioned, should it be too low in density. [L. M. D.]

Piece or Task Work.—Remuneration, in this case, is made by payment on results instead of by time. The system is applied not only to agricultural work, but to almost all industries. It may be adapted to areas, cubic contents in terms of acres, yards, bushels, quarters, or gallons, or numerically, by the score, hundred, or thousand. In some cases the entire work is done by hand, but in others the employer finds the machines, horses, or engine, and pays an additional amount for manual labour. The principle may be extended to live stock, as when a consideration is paid for collecting eggs, at the rate of 1*d.* or 2*d.* per score, for chickens marketed, or for pigs weaned. It is also used by sheep-farmers, who encourage their shepherds by extra payment for lambs weaned, and twins reared.

Piece work sometimes includes a series of operations, as when the entire harvesting of a corn crop is contracted for, the gross sum being divided by the party engaged. Piece work may even be applied to tillages, the men receiving a certain remuneration per acre, or per score acres. So far as farm work goes, there is ample scope for task work, and the system is highly popular with the men. Its advantages are patent, and may be enumerated as follows: First, it enables men to earn more money than when paid daily wages. If the price of the work is fairly adjusted, it is a matter of indifference to the employer if his men earn even double their ordinary wage. The principal point is, that the price should be so regulated that, while the men can make higher wages, the cost per acre or per unit should on the whole be less than it would be on day wages. The master is relieved from the duty of seeing that the men keep precisely to hours, or do not idle over their work, and this produces a sense of independence on the part of the labourers. It enables a good man to reap the reward of his skill and industry, while, if the price is equitable, it does not distress a man of average strength. The principle has never been accepted by trade unionists, because it is said to press heavily upon weak men; but this objection is scarcely valid, as weak men are not worth the current rate of pay. There are some more formidable objections than this to piece work, which are not, however, sufficient to condemn it. The most evident of these is, that men are inclined to scamp or slur over their work, or to prosecute it at unfitting times. Men on task work grudge waiting for land to dry, for hoar frosts to disappear, or until hasty showers have blown off the corn or hay. It is the interest of the labourer to get the work done quickly, while it is that of the master to get it done well; and the consequence is that men on task work require to be looked after closely. Another difficulty is fixing the price, for if it is too high, the men take it easy and make full wages on short time. The best method of getting over this difficulty on farms is to preserve one uniform price of average application, as this saves all argument, as the average character of the work tends to neutralize inequalities.

If the price of hoeing turnips, for example, is constant, the men learn to take the rough and smooth together; and if they make less on one area, they are compensated upon another. It is also advisable, in the letting of root-crop hoeing, to contract with the same men for both first and second (or third) hoeing, as they then take pains with the first hoeing or singling, in order to save themselves trouble in the future.

Piece Work done exclusively by Hand.—Hoeing is one of the most general forms of task work, and is often let to men not regularly employed upon the farms; it may be, to a gang or party, or to individuals who work separately. The principal complaints with such men are, that the ground is hard, and not sufficiently horse-hoed or harrowed for their taste. These complaints should be met as far as possible, but they must sometimes be resisted as unreasonable. Another difficulty occurs when men leave their hoeing for a few days, and, on their return, find the weeds thicker and the roots larger—the consequence often being a strike. This is very annoying, especially as no other men will be found anxious to go into the job, and sometimes it must be finished at great cost by day labour. Such an experience counsels caution in letting hoeing to strangers, or to men who cannot be relied on. Piece work should, as far as possible, be let to the regular hands on the farm, who in this way are enabled to make good wages during the summer. Bad hoeing is injurious to the root crop, and men who cut out too many plants, leave 'doubles', and fail to cut all weeds, are not fit for the work. A man's hoeing can be identified as easily as handwriting, and a scrawly, badly hoed ridge can generally be traced to its author. The price of hoeing is about 6*s.* per acre for singling, and 4*s.* for second hoeing, but both are better let together at 10*s.* or 11*s.* per acre. Mangel hoeing is more expensive, as the crop ought to receive three hand hoeings, which should be let to the same party at from 18*s.* to 20*s.* per acre. Hoeing corn varies in price with the tenacity of the soil and the weediness of the crop. There are many other descriptions of hoeing, such as of peas, beans, potatoes, carrots, and cabbages, each of which has its price, as see the list given below. The season begins with flat-hoeing cabbages, corn, peas, and beans, and is followed with the singling of various root crops, succeeded by second and third hoeing, which last up to harvest.

Docking and Thistleing, or the pulling of the larger weeds out of corn crops, may be let at

1s. to 2s. per acre. It, however, requires to be carefully overlooked, as it is often too rapidly performed and numberless less conspicuous docks and thistles are left, which ought to have been removed.

Haymaking is too precarious for piece work, although mowing is an exception. Grass is now so generally cut by machines that hand mowing is at a discount, but water meadows, owing to their soft nature, and the occurrence of ditches and waterways, are always mown by hand. The price varies from 6s. to 12s. per acre, the lower price being given when the work is performed by regular hands, and higher prices when the master is obliged to call in 'strappers', and in the latter case the price is given under protest. As to other works connected with haymaking, such as tedding, turning, pitching, loading, and rick building, they are peculiarly liable to interruption, and are often done by united effort, every available man or woman, including the master himself, taking part. This is not consistent with letting the work, as even household servants may be requisitioned in order to get up the hay. A small additional wage of 2*d.* per acre is often given to the man who drives the mowing machine, and the same allowance may be made for corn cutting, with the object of expediting the work. The sum per acre is small, but considering that 12 to 15 ac. may be cut in the day it is considerable to the man, and quite sufficient to induce him to keep moving (with a relay of horses) without stopping even at the dinner hour, and until late in the evening.

Piece Work in Harvest.—One of the most important developments of piece work is associated with corn harvest, and it is possible to let the whole work for a specified sum. It is, however, more common to let the different descriptions of harvest work separately, but older practice has been much interfered with by the self-binders. The various kinds of work which may be let by piece are as follows: Setting up stooks behind the binder may be let at 1s. per acre; cutting round the field in order to give access to the machines, at 2*d.* per acre taken over the whole field. Where reapers are employed, tying up wheat or oats costs from 4s. 6*d.* to possibly 8s. per acre where the straw is long and bulky, as in the fens of East Anglia. Barley is often mown by hand, especially when the crop is laid or swayed, and the ears are too close to the ground. In such circumstances hand mowing is preferable to machine work, and may be let at from 3s. to 4s. per acre. Wheat mowing is mostly a thing of the past, but in some cases may be advisable, and will cost from 9s. 6*d.* to 12s. per acre, including mowing, tying, stooking, and raking. Pitching and loading may be let at 1s. per acre, and rick building at about the same price. Thatching ricks costs 5*d.* per square of 100 ft.; 'yelming' or drawing the straw is done at an additional cost of ½*d.* per bundle, or 1½*d.* per 'steep' of five bundles. The cost of carrying is 8*d.* per acre without horse labour, and the total cost of harvesting a good crop of wheat works out as follows:—

	s.	d.
Cutting with self-binder	4	3
Stooking (let by piece)	1	0
Pitching and loading (let by piece) ...	1	0
Rick building	1	0
Thatching and drawing straw (both let)	1	0
Horses drawing wagons	0	9
Total minimum cost	9	0

If the entire harvest work is let to the men, a contract should be drawn out and signed, providing that the horses and other descriptions of live stock shall be duly attended to, and that the work shall be done in an approved manner; the master providing horses, wagons, and machines. The price fixed will vary with the character or weight of the crops, but may be assumed, for our present purpose, at 10s. per acre. The advantage of this system is that the cost of harvesting is known beforehand, and that less supervision is necessary. One incidental advantage is, that all unnecessary idling, in shifting from field to field, is avoided; and bad weather affects the master, not the man. On the other hand, there is a danger, which ought to be provided against, that the men may continue to work during rain, or when the corn is not fit to touch.

Storing Root Crops.—The list of task-work prices below will give the most essential information regarding piecework. It is, however, necessary to state that the price must depend upon the bulk of the crop, and that the horse labour is not included. The cost of storing potatoes, carrots, or parsnips is heavier than that of storing swedes, turnips, and mangel, and covering and thatching down must be added.

Letting Tillages by Piece Work.—Ploughing and other tillages are seldom let by piece, and these operations are more conveniently done on day pay. It is difficult to ascertain the exact area harrowed, twice harrowed, extra cultivated, &c. Still, there are cases in which the principle of piece work may be extended to tillages, and one has recently come before the attention of the writer, in which all the work of a large farm is let by piece. It can scarcely be hoped that such a system will relieve the master of trouble, as it must involve a vast amount of measuring and computation, besides a strict record of cash advances made during the progress of the operations. There are evidently classes of work especially suited for piece work, and others of a scrappy character which could scarcely be priced on any satisfactory basis. The following are examples of piece work applied to tillages. The horses and implements are supplied, and daily wages are suspended, so that remuneration depends upon the number of acres cultivated.

Ploughing with double-furrow plough, 1s. 4*d.* per acre.
Drag-harrowing with 4 horses, 3½*d.* per acre.
Harrowing with 2 horses, 3s. per score acres.
Cambridge rolling and heavy rim rolling, 3*d.* per acre.
Raising ridges with single plough, 1s. 6*d.* per acre.
Splitting ridges with single plough, 1s. 6*d.* per acre.
Drilling corn with single plough, 3½*d.* per acre.
Sowing corn with broadcaster, drawn by one horse, 2*d.* per acre.
Horse-hoeing roots (dependent on width of row of hoe), say 6*d.* per acre.

Piece Work as applied to Live Stock.—In this case the remuneration is rather an encouragement to attention on the part of stockmen or women than a system of payment. Shepherds, in addition to about 15*s.* per week wages with house, garden, &c., may receive:—

1*d.* for every lamb weaned.
6*d.* to 1*s.* for every pair of twins weaned.
1*s.* for every ram sold (on ram-breeding farms).

Dairy- or cattlemen are often paid 3*d.* for each pig weaned, and they or their wives 1*d.* or even 2*d.* per score of eggs collected, and 6*d.* per couple for all fowls marketed or sent into the house. The principle is capable of extension, for the head teamsman might be offered 5*s.* for each foal born alive and well, and 1*s.* might be thought an inducement to the dairyman on every calf saved. In one case known to the writer the dairyman is paid 1*s.* 6*d.* per cow per week instead of wages, and finds milkers.

Regulation of Prices for Work.—The price of every kind of piece work is determined by the amount of work which an able-bodied man may be reasonably expected to do per day. Thus if a man can do ¼ ac. per day of any particular work, the price per acre should be four times a day's work. This method of computation is just, for if by extra exertion and longer hours the man earns more than day pay, there is no cause of complaint; or if he only works at ordinary speed, and for the usual hours, he at least receives his day pay. Thus a system of labour *constants* has been arrived at in which 1 would represent the ability of 1 man to do 1 ac., 1 ton, or any other unit on which the price is based, in 1 day. If a man can do ½ ac. per day the labour constant is ·5, and the price per acre is arrived at by multiplying the day's wages by ·5, so that if 2*s.* 6*d.* is the current wages, 5*s.* will be a fair price per acre. Similarly, if ¼ ac. is a fair day's work, 10*s.* will be a fair price per acre.

List of Prices for Piece Work.—In constructing a list of prices for piece work, the best plan is to take the different sorts of labour in chronological order as follows: (1) Preparation of the ground; (2) Sowing; (3) Hoeing; (4) Harvesting and haymaking; (5) Preparation for market; (6) Storing root crops; (7) Miscellaneous; and (8) Live Stock.

Section I.—Preparation of the Ground

	Per acre.
(For horse tillages, see sections on 'Letting Tillages'.)	
Digging—To turn over with a light spade 2 to 3 in. deep, without using the foot, 1*d.* per rod	13*s.* 4*d.*
Digging—To dig 5 or 6 in. deep, using the foot, 2*d.* per rod	£1, 6*s.* 8*d.*
Digging—To dig 9 to 12 in. deep, using the foot, 3*d.* per rod	£2.
Trench digging—{Top soil, 3*d.* per rod; In trench, 5*d.* per rod}	£5, 6*s.* 8*d.*
Breast-ploughing old sainfoin lea, after raftering	18*s.*
Burning ashes for drill, 1*d.* per bushel of ashes produced.	
Burning ashes, 2*s.* to 2*s.* 4*d.* per cubic yard.	
„ „ 2*s.* per cubic yard of 21 bushels.	
Filling and spreading manure, 16 loads per acre	4*s.* 6*d.*
Filling manure, 1½*d.* per load, or 2*s.* per score loads.	
Spreading manure, 1*s.* 6*d.* to 2*s.* per score loads.	
Turning manure, 1*d.* per load; ½*d.* to ¾*d.* per cubic yard, measured after heap litter.	
Turning manure, 1*s.* per score loads.	
Sowing artificial manures, 3*d.* per acre; 1*d.* per cwt.; ½*d.* per bushel, for roots.	

Section II.—Sowing

Sowing corn broadcast by hand	3*d.* to 4*d.*
Sowing clover broadcast by harrow	2*d.*
Dibbling beans, according to distance between drills	5*s.* to 9*s.*
Planting cabbages, according to distance	5*s.* to 10*s.*

Section III.—Hoeing

Singling turnips or swedes	5*s.* to 6*s.*
Hoeing „ „ (twice)	10*s.* to 11*s.*
„ „ „ (thrice)	12*s.* to 13*s.*
„ mangel „ (thrice)	18*s.* to 20*s.*
„ cabbages, set out	4*s.* to 5*s.*
„ carrots	10*s.*
„ wheat	4*s.* 6*d.* to 6*s.*
„ peas	4*s.* 6*d.* to 5*s.*
„ beans	5*s.* to 6*s.*
Docking and thistleing	1*s.* to 2*s.*

Section IV.—Harvesting and Haymaking

Mowing clover or sainfoin	4*s.* to 5*s.*
„ old meadows	6*s.*
„ water meadows	7*s.* to 12*s.*
„ barley	2*s.* 6*d.* to 4*s.*
„ wheat	3*s.* to 4*s.*
„ tying up, stooking, and raking wheat	9*s.* to 12*s.*
Hand reaping, binding, stooking	10*s.* to 20*s.*
Pitching in field and on to rick, including loading	1*s.* to 1*s.* 2*d.*
Thatching (straw provided, drawn), 5*d.* per 100 sq. ft. for wheat.	
Thatching (straw provided, drawn), 4*d.* per 100 sq. ft. for barley.	
Thatching, 1*s.* per square (straw not drawn).	
Cutting peas and placing in 'wads', 6*s.* per acre.	
Cutting beans and stooking, 7*s.* to 8*s.* or 10*s.* per acre.	

Section V.—Preparing Crops for Market

Threshing by contract—Wheat, 1*s.* 4*d.* per quarter.	Contractor finds engine and machine, with driver and feeder.
Threshing by contract—Barley, 1*s.* 2*d.* per quarter.	
Threshing by contract—Oats, 10*d.* per quarter.	
Winnowing, 2*d.* per quarter.	
Screening, 2*d.* per quarter.	

Section VI.—Storing Root Crops

Heaping swedes, and covering with straw and earth	7*s.*
Pulling, cleaning, heaping, and covering swedes	8*s.* to 9*s.*
Mangel—pulling, and putting ready for filling	6*s.*
Mangel—pulling, and throwing on to cart	8*s.* 6*d.*
Potatoes—gathering after ploughing	15*s.*
„ —digging, gathering, and filling carts	20*s.* to 25*s.*
Carrots—lifting, and filling carts (heavy crop)	20*s.* to 25*s.*
Carrots—lifting, and filling carts (ordinary crop)	15*s.*
Covering triangular heaps 6 ft. wide at base with straw and 8 in. of soil, 10*d.* to 1*s.* per rod in length.	

Section VII.—Live Stock

To take full care of a dairy of cows and find milkers, 1*s.* 6*d.* per cow per week.
Sheep shearing, 3*s.* 6*d.* per score for stock sheep.
" " 4*s.* per score for market sheep.
Shepherd, 1*d.* per lamb reared (extra wages).
" 6*d.* to 1*s.* per pair of twins reared (extra wages).
Henwife, 1*d.* to 2*d.* per score of eggs; 6*d.* per couple of fowls; 3*d.* for old hens (extra wages).
Pigman, 3*d.* per pig weaned (extra wages).

Section VIII.—Miscellaneous

Trussing hay, 2*s.* 6*d.* per ton.
Trimming hedges, one year's growth, 2½*d.* per chain.
" " two years' growth, 6*d.* per chain.
Laying hedges, 2*s.* 6*d.* per chain.
Cutting hedges, 3*d.* to 4*d.* per rod (not often let).
Scouring hedges, 6*d.* per chain.
Dry-stone walling, 4*d.* to 5*d.* per yard.
Stone breaking, 9*d.* to 2*s.* 6*d.* per cubic yard.
Stone picking, 1*s.* per cubic yard.
Making faggots, 6*d.* per score.
Digging 3-ft. drains, 1*d.* per yard run in uniform clay soils.
Laying pipes in trench, ½*d.* per rod.

[J. Wr.]

Pieris, a genus of butterflies, including those generally known as 'whites'. They lay

Fig. 1.—*Pieris brassicæ* (White Cabbage Butterfly)

their eggs upon vegetables, on the leaves and pods of which the caterpillars feed, committing great ravages amongst cabbages, turnips, rape, and mustard. The three common species are:

1. *P. brassicæ* (the White Cabbage Butterfly, or Large White).—It frequents fields and gardens from April to October. The male is white, with the upper wings tipped with black, and the under ones with a black spot on the upper edge. The female has two large black spots on the superior wings, and a splash upon the lower margin; on the under side the two black spots are apparent in both sexes. The butterfly is nearly 3 in. across the extended wings (fig. 1, *a*).

The female lays her bright-yellow, conical eggs, in clusters of twenty or thirty, on cabbage, turnip, mustard, rape, radish, horse radish, and watercress leaves (fig. 1, *b*). The caterpillars are slightly hairy, green above, yellow beneath, with a yellow line down the back, and lines of black dots on each side, and larger ones below them (fig. 1, *c*). When full grown they are 1½ in. long, and soon attach their tails to some object, suspend their bodies by a thread, slip off their last skin, and change to shining chrysalides, of a pale-green tint, spotted with black (fig. 1, *d*).

A little fly called *Polynema gracilis* lays its eggs in those of the butterfly. The caterpillars are punctured by *Apanteles glomeratus*, the maggots of which come forth and form little

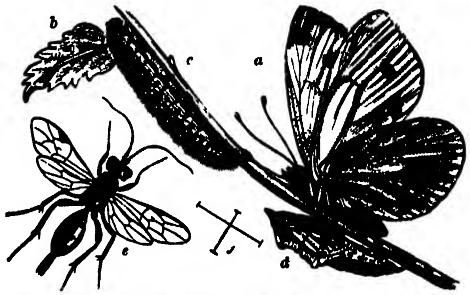


Fig. 2.—*Pieris napi* (Rapeseed or Green-veined White Butterfly)

yellow cocoons round the exhausted caterpillar; *Pimpla instigator* also lays an egg in each larva, and thousands of the beautiful little *Pteromalus puparum* (fig. 1, *e* natural size, 1, *f* magnified) likewise issue from them.

2. *P. napi*, Linn. (the Rapeseed or Green-veined White Butterfly, fig. 2, above), is white, with the tips of the superior wings, as well as the nervures, powdered with grey. In the female the nervures in the superior wings are darker, the apex blacker, with two large black spots beyond the centre. On the under side there are two black spots on the upper wings, but the apex is

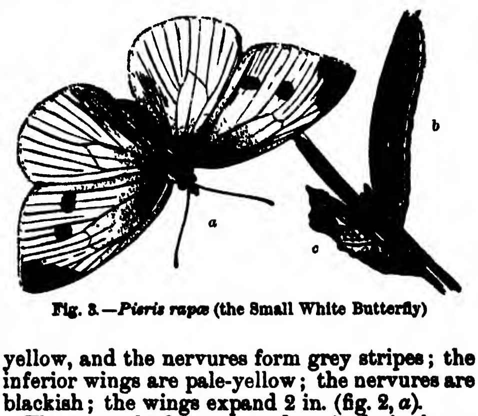


Fig. 3.—*Pieris rapæ* (the Small White Butterfly)

yellow, and the nervures form grey stripes; the inferior wings are pale-yellow; the nervures are blackish; the wings expand 2 in. (fig. 2, *a*).

The sugar-loaf eggs are deposited singly on the under side of turnip and cabbage leaves (fig. 2, *b*); but it is the central parts of the plants which the caterpillars principally destroy; these are velvety and delicate green; the spiracles down each side orange (fig. 2, *c*). The chrysalis is pale greenish-white, freckled; the beak and point brown (fig. 2, *d*). An ichneumon, named *Hemiteles melanarius* (fig. 2, *e* natural size, 2, *f* magnified), breeds in numbers from the pupæ.

3. *P. rapæ*, Linn. (the Turnip Butterfly, or

Small White), is very similar to *P. brassicæ* but smaller, expanding 2 in.; the female is a little larger (fig. 3, *a*). The eggs also resemble those of that butterfly, but the female lays them singly on the under side of the leaves. The caterpillars, however, are totally different (fig. 3, *b*); they are velvety and green, the belly paler and brighter; there is a yellow stripe down the back, and another along each side. They attain an inch or more in length, and change to chrysalides of a pale flesh-brown colour, freckled with black (fig. 3, *c*). The best remedy for clearing plants of these pests is hand-picking, as soon as they are visible. [J. C.] [C. W.]

Pigeons, zoologically considered, form a large family of birds—Columbidæ, widely represented throughout the world, especially on islands, and notably in the Australasian region. They vary from the size of a goose (*Goura*) to the size of a sparrow (*Columbigallina*). The majority inhabit wooded country, where vegetation is plentiful, and water readily accessible. Most are vegetarian, and many are very destructive to crops, though larvæ, slugs, and worms are occasionally eaten. Unlike most birds, they take continuous draughts of water, keeping the bill well immersed. All are in the habit of perching, and many different kinds are fond of sunning themselves. The note is always a coo, but it differs greatly in character. Many species are gregarious, and huge flocks are sometimes formed, *e.g.* in the case of the Passenger Pigeon (*Ectopistes migratorius*) of Eastern North America, now almost extinct, which used sometimes to occur in literal millions. In most cases the nest is a rough platform of sticks, and two white eggs are laid. Pigeons are zoologically interesting in many ways—*e.g.* they produce by a degeneration of the lining of the crop a creamy fluid, 'pigeons' milk', which is given by both parents to the young; some show highly developed conjugal affection; the trained 'homers' exhibit a striking sense of direction. But perhaps the fact of largest interest is that the wild Rock-dove (*Columba livia*) has been the origin of the domestic breeds which are now so numerous and so varied. Darwin has marshalled the evidence proving this point, showing, for instance, that the social, non-arboreal habits, the kind of cooing, and other characters of domestic pigeons point to *Columba livia*; that this wild bird has a wide range of distribution; that it is very variable in plumage, easily tamed, and actually domesticated; that all races of domestic pigeons are fertile when crossed, and their offspring are usually fertile—two facts which point to one origin for all; that all domestic pigeons tend to revert to the type of the Blue Rock-dove; and so on. Besides *Columba livia* we have in Britain the Wood Pigeon (*Columba palumbus*), the Stock-dove (*Columba œnas*), and the Turtle-dove (*Turtur communis*). [J. A. T.]

Pigeons, Domestic Breeds of.—There are a great many varieties of fancy pigeons. Opinions differ on their origin, but the generally accepted belief is that all varieties have sprung from one parent stock—the Blue Rock.

Fancy pigeons are very extensively cultivated in the way of hobbies, and particularly for exhibition purposes, not to speak of the pigeons kept for racing, which forms a sport or hobby by itself. Many hundreds of shows are held annually, at which thousands of beautiful and very valuable pigeons are exhibited, for prizes ranging from a few shillings up to gold and silver trophies of the value of 100 gs. The largest and most important of these exhibitions is the grand International Poultry and Pigeon Show, held annually at the Crystal Palace, Sydenham, London. At this show nearly 5000 fancy pigeons are staged for competition every year, their collective value being anything from £50,000 to £100,000. These birds compete for about 1500 money prizes, over 200 gold and silver cups, and other special trophies. Many small fortunes are invested in, and have been made out of, breeding and exhibiting prize pigeons; and much literature has been published on the subject. The leading and most extensively kept breeds, however, are as follows:—

The Carrier is known as the King of Pigeons. It is bred in several colours, viz. black, dun, white, blue, silver, red, and pied. The head should be long, straight, and narrow; the beak long, straight, and thick. The beak wattle is the most important property. It should be as large as possible, and its surface should resemble a cauliflower. The eye-cere should be large and circular; the neck long and thin; the tail long, but carried clear of ground. The bird should have a graceful carriage. See Plate.

Pouters may be blue, black, red, yellow, &c. The rump, breast, legs, and belly, from a point just below the breast bone to the vent, should be white. The remainder of the bird should be one of the colours above named, except the half-moon marking, and about a dozen evenly distributed white feathers on the shoulder butts, which should form a kind of rose. (See Plate.) The chief characteristic of the breed is the crop, which when inflated should be very large and globular, and distinguished by the aforesaid white half-moonlike marking well below the throat. Pouters should be tall, slender in girth, possess long legs set close together, and the feet should be covered with feathers.

Pigmy Pouters are really miniature Pouters and should have the same properties, except that the birds altogether are smaller.

A Norwich Cropper is also after the same style as the Pouter, and is shown in practically the same colours. It blows a larger crop, but is rather different in shape, and is clean-legged. It is also shorter in stature than the Pouter.

The Fantail is a charming variety for ladies. The colours are whites, blacks, blues, reds, yellows, silvers, duns, saddles, laces, &c. The tail of a Fantail, which is its most distinctive property, should be fan-shaped, concave and circular, closely filled with long, broad, evenly set feathers, well overlapping each other. It should stand on tip-toe, and walk in a jaunty manner, with the head thrown as far back as possible, and the chest, which should be round and broad, carried in a straight line with the legs. A good Fantail is constantly moving its head backwards and forwards, accompanied by a tremulous quivering of the body. See Plate.

The Dragoon is one of the most popular varieties. It is shown in the following colours: blue, blue chequer, silver, silver chequer, grizzle, red, red chequer, yellow, white, and mealy. A good specimen should have a wedge-shaped, broad skull, well filled up behind the wattle, slightly convex from eye to eye, and with an unbroken curve from the base of the wattle to the back of the head. The beak should be horizontally in a line with the centre of the eye, thick and ending bluntly. The wattle should be peg-shaped; the cere small, hard, and finely laced; the neck of medium length and thickness; the breast broad and full; the tail and flights short; the carriage erect. See Plate.

The English Owl is another very popular breed. Silver, blue, dun, chequer, black, red, yellow, pied, and mealy are the colours generally met with. An English Owl should have a large and essentially round broad head. There should be no indentations or corners from the back of the head to the tip of the beak. When viewed in profile, the head should present an unbroken curve. The beak should be short and thick, and should be so placed as to form a part of the curve above referred to. The eyes should be placed very centrally in the head. The bird should have a full gullet—loose skin reaching from the under mandible of the beak to the breast—and a pronounced frill. Its chest should be full and prominent, its flights and tail short, and its carriage jaunty. See Plate.

The African Owl is really a miniature English, and the same remarks apply, except, of course, that it is an altogether smaller bird. It is bred in the same colours as the English, with the addition of white and lavender.

Turbits may be black, red, yellow, blue, silver, dun, and strawberry. The head, which is the chief property, should be large and wide, with a well-bulged and full frontal. The beak should be short and thick, the gullet and frill full, the flights and tail short, and the carriage bold and jaunty. At the back of the head the feathers form a peak and mane. The only coloured portion of a Turbit are the wings or sides, the remainder of the bird, including the flights, being white. See Plate.

Long-faced Tumblers are divided into two sections—clean-legged and muffed-legged. Muffed-legged means feather-legged. The colours of the clean-legged are mottles, rosewings, beards, balds, whitesides, blacks, reds, yellows, whites, blues, silvers, chequers, grizzles, almonds, kites, agates, and duns. The colours of the muffed-legged are mottles, rosewings, blacks, reds, yellows, whites, blues, silvers, badges, and saddles. A good Long-faced Tumbler should have a slightly oval and full skull, a straight, close-fitting beak, white eye, small cere, cobby body, sprightly carriage, &c. See Plate.

The Short-faced Tumbler is very different to the Long-faced. The colours of this variety are almonds, mottles, agates, kites, self colours, balds, and beards. The head is often called the 'knob', the reason being that it should have a very full projecting frontal, and a large and circular crown. Its beak should be like that of a bullfinch—short, straight, and thin. In size, the Short-faced Tumbler cannot be too small and plump. It should stand on its toes, and its flights should be carried below its tail.

The Magpie is bred in the following colours: black, red, yellow, dun, blue, and silver. Like the Turbit it is a particoloured pigeon, being white on the belly, thighs, shoulder coverts, and flights. It is a small-bodied bird. The head is long, fine, and thin, and the neck long, thin, and snaky. In shape it should present a long, thin, snakelike appearance, and its carriage should be graceful and ladylike. See Plate.

Oriental Frills consist of many different varieties, the principal of which are the Oriental Turbit, Turbiteen, Domino, Blondinette, Satinette, Vizor, Bluette, Silverette, Sulphurette, &c. To describe even a few of the different properties, colours, &c., would require a lot of space. Some of these breeds have peaks like the Turbit, while others have not. Generally speaking, the shape of the head should be like that of an African Owl, as also should the shape. The markings, however, are about the chief feature of Oriental Frills.

Another unique variety is the Jacobin, of which there are blacks, whites, reds, yellows, blues, silvers, strawberries, chequers, kites, and pieds. The Jacobin has a very curious feather formation round the head. This is in the form of a hood. Coloured Jacobins should have white heads, flights, and tails. The flights and tails should be very long. The bird generally should have unusual length of feather. See Plate.

The Show Homer is not used for flying purposes. The colours are silvers, blues, silver chequers, blue chequers, black chequers, silver duns, mealies, yellow chequers, red chequers, &c. A Show Homer's chief property is its head, which should, when viewed from above, present an oval appearance. In profile it should be one long unbroken sweep from the tip of the beak to the back of the skull. The muzzle should be wide; the body in proportion to the head; and the flights and tail short. See Plate.

The Exhibition Flying Homer may be said to be the ordinary Racing Homer bred for show properties and for exhibition purposes only. The colours are about the same as in the Show Homer. The bird should be what is known as straight in face. It should not have the roundness or sweep of the Show Homer. The eye should be pearl in colour, and should be surrounded by as little cere as possible. The bird should be of medium size, short in tail and flights, deep in keel, with an alert, tight appearance. See also art. HOMING.

A curious breed is the Trumpeter. In colour it may be black, pied, white, mottle, &c. Over the head, completely covering the eyes, is what is known as the rose. Behind the latter, round the back of the head, is the crest. Both the rose and the crest consist of drooping feathers. The feet are completely covered with long feathers—the longer the better. Trumpeters should be as large as possible.

Antwerps are divided into three classes—long-faced, medium-faced, and short-faced, according, of course, to the length of their heads. The standard colours are silver duns,

VARIETIES OF PIGEONS

1. White Fantail
2. Black Magpie.
3. Red Chequer Show Homer
4 Blue Chequer Dragon
5 Blue English Owl
6. Blue Pouter.
7. Black Carrier.
8. Red Jacobin.
9. Yellow Self Long-faced Tumbler.
10. Blue Turbit

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mealies, red chequers, blues, and blue chequers. The chief property, as in many varieties of pigeons, is the head. This should be very large and broad, the frontal full, the gape wide, the beak thick, and the eye-cere small. The Antwerp is a large-sized pigeon.

Barbs are always whole-coloured—blacks, reds, yellows, duns, and whites. The skull should be large, the crown broad and flat, the whole presenting a square appearance. The eye should be white and the neck thin. The beak is short and thick. An important property is the eye-cere. This should be large, round, and coral-red in colour.

As to the management, breeding, and feeding of fancy pigeons a great deal might be said, as many of the varieties require very different management and feeding according to their individual requirements. The most successful breeders specialize in one or two breeds, and are thus able to keep their particular varieties under the essential conditions required. Some breeds of fancy pigeons are better if kept much in the open air, while others must be kept strictly protected from the weather. All pigeons should have plenty of fresh air, but those whose colour, plumage, &c., are affected by the sun, wind, and rain, must—if they are intended for exhibition purposes—be protected. Such varieties as Dragoons, Racing Homers, and the High-flying varieties are better with more or less liberty and fresh air; while Carriers, Barbs, Fantails, Jacobins, Turbits, Long- and Short-faced Tumblers, Orientals, Pouters, Pigmies, English and African Owls, Magpies, Trumpeters, Archangels, Show Tipplers, Scandaroons, Nuns, and other varieties of colour and feather properties, are better if kept wholly or partially protected. In consequence of the great value attached to exhibition specimens, and the consequent risk that would be run if they were given their entire liberty like common pigeons, the general plan is to keep them in what is known as lofts or houses—facing south preferred—from which they are allowed to go into enclosed and commodious wire-netted pens or flights. The birds are thus enabled to obtain the necessary health-giving fresh air, without their owners running the risk of losing them. The pens or flights are either entirely open or partially covered in, according to the special requirements of the pigeon-keeper. Most pigeons are better with as much fresh air, light, and sunshine as they can obtain.

The feeding varies somewhat, a little alteration being necessary for some breeds. Generally, it may be taken that feeding twice a day, morning and evening, is sufficient, and that a mixture of equal parts of small, sound New Zealand or Tasmanian peas and tares, with a half quantity of wheat and small maize, is a good all-round mixture, and is a suitable food for most varieties. As an occasional stimulant or pick-me-up, a little hemp and canary seed may be given. Fresh, pure drinking water must be supplied daily, and that in a suitable vessel whereby the birds cannot foul the water. Pigeons are clean and dainty feeders, and it is essential that highly bred, valuable specimens should have corn that is sound and free from dust, and water that is fresh and clean. Fouled or polluted water, sooner or later, causes trouble in a stud of prize pigeons. In addition to food and water, pigeons kept in captivity must have given to them what is known as prepared grits. These are advertised in the weekly papers which are devoted to pigeon culture. Some grits are medicated, while others are simply sharp, hard flint broken very small. These grits are eaten by the pigeons, and act as grinders of the corn in the birds' gizzards. Old loam, bricks broken to the consistency of coarse sand, broken oyster shells, river or ordinary sand, and other shell-forming substances may also be given. Sand or sawdust may be used as a floor covering for the houses, and the floors of the flights may either be concreted or covered with coarse sand, strewn over a floor specially prepared of clinkers and loose stones to keep it dry. High-class pigeons can stand much cold, but not draughts and damp.

Prize pigeons, unlike common ones, are only allowed to breed for a limited period each year. The pairs are mated up, say, about St. Valentine's Day, and separated about the end of July. The remainder of the year the cocks are kept apart from the hens, the former all being placed in one loft and the latter in another. The breeding season is one of the most important, and also the most enjoyable in a pigeon-keeper's hobby. Upon the skill displayed in correctly mating the birds—the balancing of one's faults with the good properties of the other—greatly depends the success of the breeding operations—the production of the prizewinning specimens. Much care and study are bestowed upon this branch of the pigeon-lover's art. The short-beaked varieties of fancy pigeons cannot satisfactorily feed their own young. For these, common pigeons have to be employed as feeders. The eggs when laid, or the youngsters when hatched, are transferred from the prize pigeons to the common ones which are known to have laid at the same time. [J. E. W.]

Pigeons—Damage to Crops.—Very serious damage is caused every year on almost every farm by pigeons which, unlike some other birds or animals which live at the farmer's expense, seem to bring little if any advantage to compensate for the valuable food they consume. In this way the Wood Pigeon is more of a rogue than the Rook, for whom something good can be said. It has to be admitted that the pigeon, at certain seasons, eats and destroys the seeds of a few weeds, but for the most part he prefers clovers, turnip leaves, barley, oats, potatoes, and swedes, and above all the seeds of peas and vetches.

Wood pigeons are exceedingly wary, and the destruction of them to an extent sufficient to affect their numbers is a matter of great difficulty. In summer they appear singly or in twos or threes, but in winter they are gregarious and often the flocks are very large. As has been indicated, the favourite food of the Wood Pigeon is grain when it can be got, either at seedtime or when it is ripening or standing cut in the fields; but at certain seasons he is very fond of clover, and many promising

fields have been ruined by his attentions. The leaves of young turnips seem also to be approved as articles of diet. He is not only partial to what is of value to the farmer, but his appetite is great, and the destruction and loss he can cause in a short time is very serious. In the year 1894 Sir John Gilmour of Montrave made a most thoroughgoing investigation into the manner of life of the Wood Pigeon, and he has recorded his experiences in the 1896 volume of the Transactions of the Highland and Agricultural Society (p. 24). To this article the reader is referred. There it is shown, by exhaustive tests, not only what food pigeons prefer, but the season of the year when they get it. There too it is demonstrated that the seeds and leaves of noxious weeds form only a small part of their diet, and that they have little taste for insects or worms, save only for their nestlings when they are very young. Altogether the Wood Pigeon is one of the worst visitors the farmer has among the birds of the air—a visitor who, in return for all the food he takes, practically pays nothing in service. [W. B.]

Pigeons, Shooting of.—Pigeon shooting hardly comes within the true definition of sport, for all the elements of danger, hardihood, and nerve are lacking. The bird usually has a very remote chance of escaping, and pigeon shooting is for that reason considered by many to be unsportsmanlike and cruel. It affords, however, a good test of skill in marksmanship, for all the conditions are under control and can be equalized in the case of each competitor.

The usual method of procedure is as follows. Five traps are placed on the arc of a circle, at distances of 5 yards from each other. At the centre of the circle stands the shooter. The radius of the circle varies from 22 to 31 yds., and may be varied according to the skill of the competitor. Handicaps are arranged by altering the length of the radius. In each trap is placed a pigeon. The opening of the traps is effected by pulling a string held in the hand of a man told off for the purpose. By a mechanical contrivance this single string is made to communicate with each of the five traps, and to open one of them at haphazard; so that neither the operator nor anyone else knows beforehand which trap will open when the string is pulled. The bird is fired at by the shooter as it rises from the trap, but a point cannot be scored unless it falls and is retrieved within a fixed boundary, whose distance varies in different clubs. After each shot a new pigeon is put into the trap from which the previous pigeon was released. The bird commonly used for the purpose is the small blue rock pigeon, which is very quick on the wing. The shooter, after taking up his position, gives the word for pulling the string. It is best for him to face the middle of the five traps, in order to be equally prepared, from whichever one the pigeon escapes. [H. S. R. E.]

Pigs — Breeding, Feeding, and Management of.—There is a very general neglect in the selection of the breeding stock. Any young sow which has not been operated upon is, in the opinion of so many persons, good enough for a brood sow, and any boar, provided its services can be secured at a low fee or purchased for a little money, is considered good enough for stud purposes. It is admitted that a pure-bred male descended from parents which have been carefully selected during several generations for certain special qualities, particularly those of form and early maturity, will, even when mated with an inferior dam, transmit with tolerable certainty those particular qualities to their joint produce; and further, that this power is greater in the male than in the female parent. Such being the case, it is imperative for the pig-breeder to endeavour to secure the services of a boar which possesses the qualities of early maturity, quick growth, and quiet disposition, and to be of the form desired in the matured pig. Even when the head of sows is small it should be possible in the large majority of cases to make an arrangement with one's neighbours to conjointly purchase a pure-bred boar, and for one to keep the boar at a fixed price for its feed, a charge being made for all sows.

Now that the majority of the consumers show a marked preference for small joints of high-quality meat from animals which have matured early, the advantages arising from the selection of a sire of compact form and possessing quality of flesh, bone, and hair are increased. Especial care should be taken when selecting a boar that it is of a quiet disposition, as nothing is more hereditary than bad temper and irritability, two qualities which greatly retard the fatting process of their owner. As the size and weight, and to a certain extent the form, of the fat pigs required in different localities vary considerably, it will be advisable to select a boar of that size and form which the desired type of pig should possess, due consideration being given to the lightness but width of the head, lightness of offal and of the shoulders, length and depth of body, squareness and depth of hind quarters, straightness of legs and their position—well outside the body—all combined with masculine character. With regard to the selection of the sow very similar points should be sought, but she may be less compactly built and of greater size and length; moreover it is imperative that she should possess a well-shaped udder, with the twelve or fourteen evenly placed teats commencing as nearly as possible to the fore legs. The time of year will have some influence, but generally the best age at which to commence breeding is when both male and female pigs are about eight months old. To use a young boar or to mate a young sow at an earlier age tends to check development and also to hasten the end of the period of usefulness; whilst if the young sow be of a fat-producing breed and not mated until she is a year or more older, a difficulty sometimes arises when an attempt is made to get her in pig; and besides this, a sow of this character is less likely to prove to be a good suckler than if she had produced her first litter of pigs ere she was a year old.

The young pigs not required for breeding purposes should be operated upon when about six weeks old. Of late years the system of leaving all the sow pigs unspayed has been somewhat

generally followed; the excuses being that a certain amount of risk attended the operation, and that a trouble, as well as expense, existed in finding a competent operator. Needless to say, the trouble and risk exist largely in the imagination of the owners of the pigs, whilst the loss to the owner, butcher, bacon curer, and consumer is certain, and far more considerable than is generally believed; as after the sow pig has reached the age of five or six months, not only will she fail to make flesh, but on three or four days in alternate periods of three weeks, she will be a source of worry, and a nuisance to all the other pigs with which she can come in contact, rendering them restless and temporarily thriftless. When at last the unspayed yelt or young sow becomes fit for the butcher, her flesh will be greatly deteriorated, and in some cases unfit for the bacon curer if she be slaughtered during the period of œstrum, as the belly portion of the side of bacon will be 'seedy' or discoloured, due to the impossibility of extracting the whole of the blood from the inflamed udder.

Opinions vary greatly as to the best way to feed pigs of the various ages. The following is the system which the writer has followed with more or less success for about half a century. The sow pigs intended for breeding purposes are usually weaned when about eight weeks old; this period being extended when the dam is becoming aged or when she is very young, and in both instances had become reduced in flesh. This extra two or three weeks' good feeding with the pigs often proves very satisfactory to both mother and produce, the former becoming more vigorous, so that when mated a few days after the pigs are taken from her, she makes a good start in the production of a strong and numerous litter. The best single food for sows suckling their pigs, and also for the latter when weaned, is the offal from the grinding of wheat, which in varying districts is termed 'sharps', 'randan', 'middlings', 'thirds', &c.; whilst the best addition to this, if it be procurable, is skim milk, then separated milk, butter milk, and whey, all in comparatively small quantities, and fed at first through the sow, then subsequently, when the pigs are a few weeks old, mixed with their food. If the separated milk be fed in large quantities, indigestion and constipation attack the youngsters. This can be partially remedied by adding some form of oil or fat, but then there is a risk of making the food too rich for the digestive organs of the little pigs. Besides this, it has been proved that the proportionate benefit derived from feeding skim or separated milk to pigs of all ages becomes gradually reduced as the quantity is exceeded beyond a comparatively low point. For instance, the feeding value of 3 lb. of skim milk per day given to a fattening hog is at least twice proportionately as great as thrice the quantity. It might also be noted that skim or separated milk will give the best monetary return if fed to young rather than to old pigs, save to sows which are rearing a litter of bonhams.

Some pig-breeders contend that it is advisable to give the brood sow a rest for three weeks or more after the pigs are weaned. This means that one period of œstrum must be allowed to pass without advantage being taken of it. There may be instances when this plan might with advantage be followed, for instance when the sow has been allowed to become very reduced in strength and flesh. But this unfortunate state of affairs ought to have been avoided. The remedies are several, amongst them better and more judicious feeding whilst the sow is rearing her pigs, especially in the fourth and fifth week of that period: the adoption of the plan of allowing the pigs to remain on the sow until they are ten or more weeks old; or in care being taken not to leave an undue number of pigs in each litter on the sow. Any sow which is not in good and vigorous condition after the adoption of one or more of these suggested systems, may without serious loss from the breeder's point of view be fattened off and converted into sausages.

The same food may be continued to the young pigs after they are weaned as was given to them prior to the weaning. When they are from three to four months old, barley, oat, pea, or wheat meal may be gradually added to the sharps fed, until when the pigs are five months old the meal, and if procurable a little milk, becomes the chief food. In the spring and summer, tares, clover, lucerne, cabbages, or other green food in moderation will be of great assistance in the fattening process; whilst in winter, mangold, turnips, swedes, kohlrabi, cabbages, &c., will take their place. The results of many experiments have conclusively proved that, save for potatoes, cooking vegetable food is not economical nor beneficial.

The weight at which these larger fat pigs should be sold will depend very considerably on the market to which they are to be consigned; but it is generally acknowledged by those who have carefully weighed the food and the pigs, that as the size, weight, and age of pigs increase, so does the quantity of food needed for an equal gain of weight increase. A series of experiments carried out at several of the agricultural colleges proved that two-thirds more food was required with pigs weighing about 300 lb. to make a gain equal to that made by pigs of about 50 lb.; so that not only does the cost of manufacture of pork increase with the weight of a pig, but the pork produced realizes a correspondently reduced price on the market. Nothing in connection with the interesting pig-carcass competition has more clearly proved this fact, or has proved of greater value to pig breeders and feeders. In the production of those small pig carcasses which weigh some 60 to 70 lb. and realize so profitable a price in London and some of the towns in southern England, a more forcing diet may be employed at the age of about three months, since the object is to make the pig fat when it is from sixteen to eighteen weeks old. The risk of overfeeding—with its attendant results, tenderness of feet and stiffness of joints resulting from too stimulating food and a limited amount of exercise—may be run, as should symptoms of these troubles appear, the pig can be sent to the butcher without any great appreciable loss, whereas a lengthy pig intended for fat pork or bacon would not at

four months old make a good carcass of porket pork.

The oldfashioned system of keeping pigs in a store or growing condition for several months on a maintenance diet is gradually giving place to the more rational and profitable system of growing and fattening simultaneously, as by this means the cost of merely keeping the pig alive for some months—and this will amount to the value of at least 3 lb. of meal per day—is saved, the whole of the food value of the rich food during the fattening process is utilized, a greater number of pigs can be fattened in the same premises, and the meat from the younger fat pig will realize a higher price and meet with a better demand on the market. The older and bigger pig is a less profitable and efficient manufacturer of meal into pork, and that of lower quality, than the younger pig, since the cost of keeping the machinery running a longer time for similar results is greater. When looked at from every point of view the greatest profit is realizable from the system of intensive feeding from an early age of the pigs, since not only will the pork cost less per pound to manufacture, but it will realize a higher price and meet with a more ready sale. The cost of keeping well-bred boars as well as sows during the first three parts of the gestation period is comparatively small, as they will consume so many scraps, rough and inferior and cheap food.

The boar is best kept in an enclosed place with a shed for shelter, but the sows will produce more pigs and rear them better if allowed the run of a large yard, or a grass field. The latter will furnish the larger part of the food required for a brood sow, save during the last month of her period, when some more concentrated food, such as maize, peas, or beans which have been soaked in water for at least twenty-four hours, should be given. It is advisable not to give the brood sow food of too bulky and innutritious a character during the latter part of the time she is carrying her litter, or trouble may supervene when she is farrowing. During a fortnight prior to this last operation she should have been kept at night in the sty or house in which she was expected to farrow. There are differences of opinion as to whether newly weaned pigs should be fed at least four times per day; and whether it is better to feed fattening pigs twice or thrice daily. The writer believes in frequent feeding on as much food as the pig will at once clear up with evident relish. Some pig-feeders adopt the plan of continuing week after week to feed the fattening pig on, say, barley meal, whereas the writer would recommend a mixture of meals, with an occasional change of diet, and even an occasional absence of food by the omission of one of the ordinary meals. Some persons will recommend the mixing of medicine at regular periods in the food of the pigs, whereas this should certainly be unnecessary if the food be intelligently mixed. The problem whether the meal should be fed in a dry state, or mixed with a small or a large quantity of moisture, will be best determined by the feeder, who will be able to satisfy himself as to the special circumstances; so far the experiments carried out have favoured the system of giving the meal and the water separately. But there can be no doubt that it is advisable to have all corn which is fed to pigs ground as fine as possible, as the object in feeding a pig is to secure the greatest possible quantity of nutriment from its food with the least effort or use of energy on the part of the pig. The complete disintegration of the corn can be effected at a much less cost by the aid of steam and a mill than by the teeth of the pig. See also arts. Fattening of Farm Animals; Rations.

[s. s.]

Pigs, Breeds and Classification of.—Some thirty years ago a society of pig-breeders was formed with two objects in view: (1) to secure the registration of pedigreed pigs; (2) to draw up a scale of points for each pig breed. Since the institution of this society many changes in the art of breeding and in the popular pig types have taken place; and what were formerly regarded merely as local and unimportant types have since been officially recognized as forming distinct breeds. The leading breeds to-day are: Berkshire, Large Black, Large White, Lincoln Curly-coated, Middle White, and Tamworth. The Berkshire and the Yorkshire—the latter including the Large White, the Middle White, and the Small White varieties—were the oldest recognized breeds. Until about 1890 the Small Black was also regarded as a distinct breed by the Smithfield Club and the Royal Agricultural Society of England, but, like the Small White Yorkshire, it has ceased to be kept pure.

The oldfashioned dark-chestnut or mahogany-coloured pig of Staffordshire, Leicestershire, &c., was greatly changed in character about a quarter of a century since, and acquired the status of a pure breed by the recognition of the National Pig-breeders' Association. The breeders of those long-sided black pigs in Suffolk and Essex, and those admirers in the West country of the large and somewhat coarse black pigs, together formed a society to which the name of the Large Black Pig Society was given, whilst the most recently admitted pure breed is the so-called Lincolnshire Curly-coated pig, which is mainly produced in Lincolnshire. The characteristics and qualities of these various types and forms of pigs are briefly described under separate articles. Besides the above-mentioned breeds there are several which possess a considerable amount of local interest. The chief of these are also referred to separately. [s. s.]

Pig Breeds, Points and Characteristics of.—To give a scale of points specially applicable to each breed of pigs would occupy much space. It has therefore been deemed advisable to draw up a scale apportioning the value which may be assigned to those general points which would be considered of commercial rather than of fancy value, and yet be applicable to all breeds of pigs. In addition, the special characteristics peculiar to each breed, or sought after by judges or purchasers, are given, as well as a list of those points which are undesirable or should disqualify their possessors when in competition for prizes offered at the various shows.

Head light, but wide between the ears	5
Ears thin, of varying length, and fringed with fine hair	2
Jowl small and light	2
Neck long and muscular	3
Chest wide and well let down	4
Shoulders obliquely laid and narrow on top ...	5
Girth around the heart	4
Back long and straight	5
Sides deep	5
Ribs well sprung	5
Loin broad and not drooping	3
Belly full and thick, with at least twelve teats placed equidistant	5
Flanks thick and well let down	5
Quarters long, wide, and straight from hip to tail	5
Hams broad, full, and meaty to the hocks ...	7
Tail set on high, not coarse	2
Legs straight and with flinty flat bone	6
Ankles strong and compact	4
Pasterns short yet springy	2
Feet firm and strong	3
Hair long, straight, and silky	4
Evenness of flesh and freedom from wrinkles in the skin	5
Action free and clean, without swaying of hind quarters	4
Symmetry, general style, and contour giving proof of careful breeding	5
	100

Berkshires

Colour black, with white blaze on the face, white feet, and white tip to the tail.

Ears erect.

Objections.—Narrow forehead; short snout; heavy jowls; thick, coarse, or much inclined forward ears; white or rusty patches of hair.

Tamworths

Colour golden-red, long snout, with pricked ears.

Objections.—Black hairs, black spots on the skin, upturned snout, drooping ears.

Large White Yorkshires

Colour white.

Carcass long and deep.

Ears long and inclined forward.

Objections.—Blue spots on the skin; coarse, pendulous ears; heavy jowls; coarse skin and hair; black hairs.

Middle White Yorkshires

Same as Large White, save that the ears should be erect and smaller.

Large Blacks

Colour black.

Ears long and thin, covering the eyes and snout.

Lincolnshire Curly-coated

Colour white.

Hair curly.

Ears long and thin, covering the eyes and snout.

General Failings.—Mane or ridge of coarse hair along the back; coarse hair, skin, and bone; round ankles, and soft, porous bone; weak pasterns; splayed feet; bent legs; thin fore-and-aft flanks; light middle; blind teats; rupture; rigs, or one testicle only in the scrotum; indifferent movement; bad temper. [S. S.]

Pigs for Bacon.—The fat pig which realizes the highest price for bacon-curing purposes is one weighing alive from 200 to 220 lb., or about 155 lb. when dressed. This will furnish a side of bacon of about 60 lb. The pig should be long in the back from shoulder to hip, deep in the sides and thick in the flank, with hams long and thick, shoulders and fore quarters generally as light as possible consistent with constitution, since the head realizes little, and the neck and shoulder only a greatly reduced price; the bone, hair, and skin should be fine, as these give a good indication of the quality of the meat. In fact, the object of the producer of a fat pig for bacon manufacture should be to breed one with the greater proportion of middle, since that realizes by far the highest price; a smaller proportion of hind quarters, as the meat is of a lesser value; whilst the head and fore quarters realize about one-half as much as the middles, and much less than the hind quarters. [S. S.]

Pigs for Pork.—Those fattened pigs which from their feeding and conformation may be specially produced for the manufacture of mild-cured bacon will furnish pork of the finest quality for consumption in those districts in the northern portion of England where larger joints of fatter pork are in demand. But the more general meaning given to the term fresh pork, especially in the southern portion of the kingdom, is the meat of fattened hogs weighing when dead from 60 to 150 lb. In London and other of the largest towns comparatively few pigs exceeding 100 lb. live weight meet a ready sale at best prices. This class of pig is termed a jointer, porker, or porket pig, and is consumed very largely when roasted.

Although the consumers set the most value on the middle and hinder portions of the porket pig, as on that of the bacon pig, yet the type of pig most suitable for the bacon-curer's purpose is not perhaps exactly that type which is the most prolific for the pig-breeder who breeds and feeds for the porket trade, since the longer and more growthy pig does not mature so quickly, nor is the meat from it of quite so suitable a character for the jointer trade, as by the time the pig is fit, or as it is termed ripe, for slaughter, the carcass will have become too heavy. A smaller and more compactly formed pig, and one which will mature at a younger age, is therefore best for the roaster fresh pork trade. The Middle White Yorkshire or the Berkshire, and in many instances a cross of these two breeds, is preferred, since these pigs are finer in the bone, shorter in the body, and can with attention be made to furnish a carcass of 60 to 70 lb. at from four to five months old; the former breed and the produce of the white boar from the black sow being selected, since the pigs with a white skin look better when dressed, and are more sought after by those buyers who study appearance and flavour rather than mere cost. Although these porket pigs are consumed during the whole of the year, yet the greatest demand for them is during the cooler weather, from the month of September to April. Thousands of these pigs, of uniform

type and character and degree of fatness, are imported during the season from Belgium, Denmark, and Holland; but if the English breeders would take an equal amount of trouble as do their foreign rivals, in breeding the right type of pig, in feeding it on as suitable food at as early an age, and then marketing a uniform lot of carcasses, they would have no great difficulty in securing the best market. The object should be to produce a lengthy but compact pig of quick growth which will mature early. Success in the manufacture of this special class of pork is more readily and cheaply obtained when the feeder has for use dairy offals. In addition to these mentioned kinds of fresh pork is that required for the manufacture of pork sausages and pork pies. Fat pigs of a considerable age, which may or may not have been used for breeding purposes, form a portion of the supply of this class of pork, which realizes a comparatively low price. On the other hand, in the district round Birmingham, the type of fat pig most generally in demand is one weighing some 350 lb. alive, the pig being of the larger varieties and fattened to a greater extent than is common in the more southern portions of the kingdom. The cause for this demand for meat from older animals made more fat than usual is said to be the consumers of pork being mainly persons who are employed in severe manual labour, or whose vocation causes them to consume cold meals. [S. S.]

Pig Typhoid, a popular name for swine fever, a disease of pigs of a highly infectious and contagious typhoid character. See art. SWINE FEVER.

Pill. See ARMADILLIDIUM and WOODLICE.

Pimpernel (Anagallis) belongs to the nat. ord. Primulaceæ; it is distinguished by the wheel-shaped corolla, and by the capsule fruit opening by a lid (pyxis fruit). The species are slightly poisonous.

Scarlet Pimpernel, or Poor Man's Weather Glass (*Anagallis arvensis*), is an annual cornfield weed 6 to 18 in. high, with opposite, egg-shaped, ribbed leaves without a leaf-stalk. The corolla is coloured often scarlet, sometimes white with a purple eye, and sometimes blue; in fine weather it remains open from about eight in the morning till four in the afternoon, but on the approach of rain it immediately closes up, being excessively sensitive to moisture.

Bog Pimpernel (*Anagallis tenella*) is a dwarf creeping perennial of bogs, only 3 or 4 in. high. The flowers are rosy, with dark veins. Yellow Pimpernel is *Lysimachia nemorum*. [A. N. M'A.]

Pine (Pinus) is the only indigenous British genus of the Abietineæ tribe of the nat. ord. Coniferæ. It differs from all the other genera (Spruce, Hemlock, Silver Fir, Douglas Fir, Larch, and Cedar) in having very elongated, spirally arranged, persistent, evergreen leaves, each usually from the second year onwards enclosed by a sheath and divided into from two to five needles; cones ripening only in second year, and with narrow cone-scales more or less thickened towards the apex; and resin-ducts varying in number and disposition. The flowers are monœcious, the males being in catkins and the pollen cells winged, while the seed-wing, broad above, is attached to the seed by two clawlike processes. The cotyledons vary in number, but are three-sided and usually entire, while the primordial leaves are denticulate. The pines are all evergreen trees of large size indigenous to the hilly regions of Europe, Asia, and America. They do better on a poor than a rich soil, and they all thrive best on light, dry, porous land; and, like all other conifers, do not grow well in a smoky atmosphere, nor do they succeed on heavy, wet soil. They are mostly light-demanding trees, yet they usually grow gregariously and form pure woods over large areas, though only bearing a much smaller number of stems per acre than shade-enduring Spruces or Silver and Douglas firs (except Weymouth Pine, which endures a large amount of side shade and forms fairly dense woods). Even when growing isolated, pines usually shed most of their lower branches and form straight, clean boles with a thick bark that becomes much fissured. The leaves persist for from three to six years, according to the species and the quality of the soil and situation. On old trees the crown generally becomes oval or flattened (in place of remaining conical as in spruces and firs). Most pines form a deep and wide-spreading root system with a well-developed taproot, which enables them to resist strong gales. But their branches are brittle and apt to snap under pressure of heavy snow. Of the very numerous known species of Pine only one is indigenous to Britain, the Common or Scots Pine (*P. sylvatica*), which once formed more or less pure forests over the greater part of the Scottish hills. But many species and varieties have been introduced, chiefly from southern Europe and North America, and are now cultivated either as timber crops or for ornament, an impetus in this direction having been given by the custom of making 'pineta' on large estates, which formed valuable collections of conifers in different parts of Britain. These include pines with (1) geminate leaves (each divided into two needles): Scots, Austrian (*austriaca*), Corsican (*Laricio*), Maritime or Cluster (*Pinaster*), Taurian (*Pallasiana*), Red (*resinosa*), Pyrenean (*pyrenaica*), Dwarf or Mountain (*Mugho* and *Pumilio*), Scrub (*inops*), Bishop's or Prickle-coned (*muricata*), Persian (*persica*), Stone or Umbrella (*Pinea*), Aleppo (*halepensis*), and Banks (*Banksiana*); (2) ternate leaves (usually three, sometimes two or four needles): Gerard's (*Gerardiana*), Large-coned (*Coulteri*), Lace-bark (*Bungeana*), Yellow (*ponderosa*), Bentham's (*Benthamiana*), Pitch (*rigida*), Remarkable (*insignis*), Sabine's (*Sabiniana*), Jeffrey's (*Jeffreyii*), and Tuberculate (*tuberculata*); (3) quinate leaves (usually five needles): Weymouth or White (*Strobus*), Cembrau (*Cembra*), Himalayan or Blue (*excelsa*), Lambert's (*Lambertiana*), Mexican (*Montezumæ*), Californian Mountain (*monticola*), and Hartweg's (*Hartwegii*). But this is only a very incomplete list of the many pines introduced into Britain during the last two centuries, since the White Pine was brought from North America by Lord Weymouth in 1705. In British forestry the pines of most importance are our native Scots Pine, the Austrian (see Aus-

TRIAN PINE), Corsican, and Maritime or Cluster Pines indigenous to southern Europe, and the Weymouth Pine introduced from North America in 1705 by Lord Weymouth, and easily distinguishable from these other four by its five-needled leaves, and by its very elongated pale-brown cones having the cone-scales only slightly thickened near their tips. Apart from well-marked but purely botanical differences, these European species are usually easily distinguishable by their habit of growth, foliage, and cones. Thus the Scots Pine has comparatively short and bluish-green needles (1½ to 2½ in. long); a light-coppery or orange-coppery bark, becoming darker and thicker near the base; and more or less conical and reddish-brown dependent cones (generally in pairs) with a dull, unpolished surface. The Austrian Pine has a spreading habit of growth; a darker blackish-grey bark fissuring up to the crown; longer, coarser, darker, stiff, prickly, and more persistent needles (2 to 5 in. long); larger buds, cones, and seeds, the light-brown cones having a polished surface and usually standing out at right angles; and a large crown of open and wide-spreading branches, which are not so soon thrown off to form a clean bole. The Corsican Pine has very regularly whorled, open, and horizontal branches, with still longer and darker-green foliage (4 to 6 in.), rather slender and often twisted, and the leaf-sheaths are shorter than on the Austrian Pine; while the cones are straight or only slightly pointed at apex, conical, solitary or in pairs, 3 to 4 in. long and 1½ in. broad at base, with seed larger than Austrian and about twice as large as Scots. The Cluster or Maritime Pine or Pinaster has very long, broad, rigid, stout, dark-green foliage (6 to 8 in.), with yellow to black sheaths ¾ in. long and set in dense whorls; the buds are ¾ in. long and not resinous like those of the Corsican; while the light-brown glossy cones, 4 to 6 in. long and 2½ in. broad, are in horizontally pointing clusters usually of 4 to 8, and contain large oblong seeds with wings about 1½ in. long and ½ in. broad. On their seeds germinating the seedlings of Scots have usually 5 to 7 cotyledons, Austrian and Corsican 6 to 8, and Maritime 7 or 8. They are all trees of large size, growing up to 90 to 100 ft. high and 10 to 12 ft. or more in girth. Many of our Scots Pine are known to be between 300 and 400 years old, and the best natural woods are those in Strathspey, where the tree attains its finest development. They are all picturesque trees, though none of them surpass our native species in this respect, which also yields better and finer-grained timber than the three South European species, though it is coarser in the grain and more apt to warp than the Weymouth Pine timber imported in large quantities from America under the trade name of 'yellow pine'—the trade name for Scots Pine from the Baltic being 'red deal', and Spruce 'white deal'. For British forestry Scots Pine is by far the most important species, though Weymouth Pine grows quicker and forms much larger crops on a good, deep, dry, light loam, and in a sheltered situation; and Austrian Pine (difficult to transplant, and sometimes best moved in July) is most suited to a limy soil; while Corsican and Maritime Pines thrive well near the sea coast, and are best suited for dune-planting. The Scots Pine timber grown in the north of Scotland is redder-hearted, closer-grained, and more resinous and durable than the Baltic imports, or than what is grown in the lowlands and throughout central or southern England (where it was first planted in Ocknell Clump, New Forest, in 1776, and has since become a characteristic tree on sandy soil). It is one of the most accommodating trees as to soil, provided that this be not wet; but light soils suit it best, and its growth and its timber are there better than on any binding soil. Its finest growth is attained on the sandy gravel of Strathspey, and good timber can be grown on a dry sandy loam or gravelly loam resting on a dry subsoil allowing its deep taproot to expand. In the Strathspey district Scots Pine woods are easily regenerated naturally by leaving twenty to thirty mature trees per acre as seed-bearers, whose cones open and scatter the seed when the dry east winds come during the early spring. Before regeneration heathery stretches can be well grazed to keep down weeds, but cattle, sheep, and deer must be removed before the seedlings come up. Otherwise, it is only grown from seed, the cones being collected during the winter before the drying east winds make the cones begin to open. A pound contains about 75,000 clean seeds, which germinate in three to six weeks and yield from 60 to 90 per cent (best Strathspey selection) of seedlings. As a rule a little over ½ lb. is enough for each 100 sq. ft. of seed-bed, if sown broadcast. Home seed is preferable to foreign, as the seedlings are hardier and less liable to the leaf-shedding disease (see PINE SEEDLING DISEASE). In Scotland two-year-old seedlings are usually notched at 3 or 3½ ft. (see art. on PLANTING). If bigger plants be wanted for pit-planting, one- or two-year-old seedlings can be put into nursery lines at 4 to 6 by 6 to 8 in. apart, till of the size required, when (from their third year onwards) they form regular whorls of branches. Owing to its demand for light, Scots Pine needs thinning sooner than Spruce, Silver, or Douglas firs; but if at all overthinned it at once spreads out thick branches which tend to spoil the bole. Where once a mistake of this sort has been made at about twenty to twenty-five years of age, the only remedy is to maintain close canopy till these lower branches die and rot off, which takes place much sooner than on the shade-enduring conifers. On the Continent, when the woods are from forty to sixty years old they are thinned and underplanted with Spruce if the soil be not too dry; but if underplanting is likely to be profitable in Britain, the Silver Fir will probably be better than Spruce, though proper experiments have yet to be made in this and other directions. Young Scots Pine are very hardy against frost, but, like other conifers, this tree has its own special insect enemies and fungous diseases on roots, stem, branches, and foliage. [J. N.]

Pine.—Parasitic Fungi.—

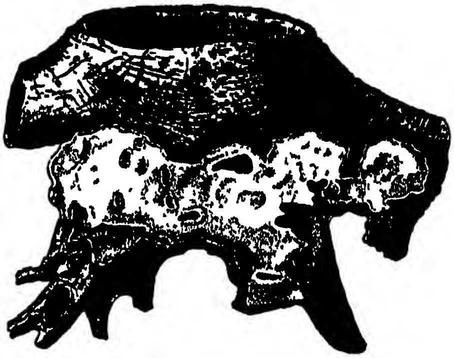
SEEDLING DISEASE.—Seedbeds are frequently

destroyed by the tree-seedling mildew and other fungi (see Beech—Parasitic Fungi, and Damping off). Seedlings and young trees of many conifers are often killed by a girdling at the base of the stem; this is caused by *Pestalozzia hartigii*, a fungus with sporules distinguished by three hornlike processes.

Leaf-cast.—Amongst the causes leading to premature shedding of needles are: frost, drought in winter with frozen snowless soil, summer drought, smoke damage, overcrowding of plants, and fungi. *Lophodermium pinastri* attacks young trees, and when established is difficult to eradicate. The symptoms are spotting and withering of the needles; ascospores are developed in fallen needles and infect new foliage. *Treatment.*—Overcrowding is to be avoided, as it harbours moisture and so favours germination of spores. Diseased plants should be removed and burnt, and, after thorough trenching of the soil, the gaps may be filled up with hardwood trees.

Rust and Stem Canker.—*Pine Blister* somewhat resembles Larch canker, and is caused by fungus-filaments which kill the young wood and bark, so that incomplete year-rings and canker patches saturated with resin result; the yellow spore-cases arise from the bark and contain æcidiospores of the rust-fungus *Peridermium* (see Fungi), young trees generally succumb, but older trees may struggle on, stag-headed and damaged in the timber. Other species of *Peridermium* attack the needles only; several of these complete their life-history on Ragwort, Groundsel, and other species of Senecio. *Pine Twister* attacks Pines, Larch, Spruce, up to ten or fifteen years old; the disease begins on the needles and extends to young twigs, which become twisted; spore-sacs arise and give off yellow spores about July; these are the æcidial stage of *Melampsora*, a rust-fungus which completes its life-history on Poplar (see Poplar—Parasitic Fungi). Stem canker has also been traced to the Larch canker fungus (see Larch Disease), and to Nectria canker (see Apple—Parasitic Fungi). *Treatment.*—Pruning off diseased branches will check these fungi, but in large plantations the best way is to thin out and remove diseased trees, and to clear out the Poplar, Groundsel, or other host-plant in the life-cycle.

Stem Rot.—The Honey Agaric (*Agaricus melleus*) is very destructive in young conifer plantations; it attacks the roots and extends to the stem, which becomes resinous and dies at the collar (see Fungi—'Hymenomycetes'). Almost equally destructive is *Trametes radiciperda*, which also begins work on the root, ultimately extending into the stem and causing a reddish-brown rot dotted with black spots with a white margin; the whitish sporophores cling to the bark near the ground. *Trametes pini* forms hard sporophores (2 to 4 in. across) on branch snags; the wood rot produced is first reddish then yellowish-white, and the timber splits into rings, hence the name 'ring scale'. Other forms of red rot are produced by various Polypore fungi (see Timber-destroying Fungi). *Treatment.*—As the root-rotting fungi frequently spread from a centre, it may be possible, as Hartig suggests, to isolate the spot by a deep trench round it; all diseased trees could then be removed, and blanks filled with Ash, Oak, or other hardwoods. During thinning, all trees showing signs of rot should be removed. Broken branches and wounds produced while felling and dragging



Stool of a Spruce, with sporophore of *Trametes radiciperda* encrusting the base (from Tubeuf)

timber are favourable places for infection; this may be prevented by painting wounds with tar.

[W. G. S.]

Pine, Insect Enemies of.—The chief pests attacking Pine are *Bupalus piniarius* (Pine Looper Moth), *Hylurgus piniperda* (Pine Beetle), *Lophyrus pini* (Pine Sawfly), *Hylobius abietis* (Pine Sawfly), *Noctua piniperda* (Owlet Moth).

Pine Seedling Disease is caused by a fungus, *Lophodermium pinastri*, belonging to the Hypodermataceæ or Scurf-fungi family of the Pyrenomycetes order of fungi. It chiefly attacks the leaves of one- to five-year-old conifers, especially Scots and Austrian Pines, and causes their foliage to wither suddenly and fall off. Leaf-shedding may occur after hard frost or severe drought; but when due to this fungous disease the young leaves in late summer and autumn show small brownish-red spots containing the mycelium, and early in the following spring the foliage dries and dies, the older leaves being shed and the younger ones usually adhering to the young shoots; and on the dead leaves shed the brown spots of autumn become small flat black fruits (*apothecia*), which burst and scatter their spores if the weather be damp in March and April, and these ripen into spore-cases (*asci*) that during the next summer and autumn spread the infection. This disease is parasitic on pines up to about twenty years of age; but it also occurs saprophytically (along with *Botrytis cinerea*) on dead, cast foliage in old pine woods, which perhaps explains the fact that Scots Pine seedlings usually come up far better and more numerously in the open or under the light shade of Larch and broad-leaved trees than in the pine woods themselves, where the cast foliage is undergoing humification, and therefore infected with these fungi capable of becoming parasitic on the young and tender seedlings. Spraying with a solution of copper between 1st July and 15th August is the only effective protection (2 lb. sulphate of copper dissolved in 10 gal. of water,

and 1 lb. of freshly burned lime added); but in nurseries diseased plants should be pulled up and burned. [J. R.]

Pineapple.—The Pineapple (*Ananas sativa*, Schult.) belongs to the nat. ord. Bromeliaceæ, an assemblage of plants that have their headquarters in Brazil. The European hothouse pineapples are often said to be finer flavoured than those grown in the Tropics. It was raised at Leyden in 1650 A.D., and the first fruit grown in England appears to have been presented to Charles II, though for some years previously the fruit had reached the court of England from the West Indies. With modern facilities of rapid transport to Europe and America, large (and increasing) supplies have been conveyed from the West Indies (Bahamas, Jamaica, Antigua, &c.), Madeira, and the Canary Islands. This has led to a decline in hothouse production, and to the establishment of a highly lucrative new planting industry in the Tropics, more especially the countries named. While India has not as yet begun to participate, the plant grows very readily in many parts of that vast empire, and indeed in both Assam and Burma has become completely acclimatized.

The Pineapple is naturally a biennial (if raised from seed), though well-established suckers will fruit in eight to nine months from date of transplanting. It affords two chief products: the *fruit*, and a *fibre* from the leaves. The cultivation pursued is practically identical, though it is doubtful how far both products may be obtained from the same plants, since the elongation of the leaves is attainable only by conditions that injure the quality of the fruit. The best soil is a sandy loam with free drainage, but the fruit may be raised on very poor soils, such as free sands or gravels. Clay and badly drained soils must, however, be avoided, though a fair amount of lime seems advantageous. Animal manures, unless perfectly decomposed, have to be regarded as dangerous. Leaf mould mixed with thoroughly decayed farmyard manure and sand is the best treatment, but in all cases the land must be deeply ploughed, the soil thoroughly pulverized and completely freed from weeds. Shade of any kind will increase the size of the fruit but lower its merit, and at the same time cause the formation of much leaf and the sacrifice of copious fruiting. As the fruit sets, and onwards till harvest, a liberal supply of water (if at all possible) is highly beneficial.

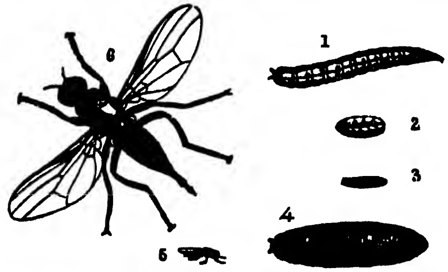
In planting out it is customary to line the suckers 3 ft. apart each way (5000 to the acre); but as the plants are very spiny, room to work the plantation is essential. Accordingly, it is often the case that the first plants are deposited 6 ft. apart on the lines (2500 to the acre). When the first crop is gathered, three to four suckers are left on each stool, thus causing the second crop to be something like 10,000 fruits. After a third or fourth such crop the plants are completely uprooted, and new suckers set on the spaces intervening with the positions of the old stools. In this way the plantation may be continued almost indefinitely, the alternate spaces obtaining a three years' fallow. Planting out usually takes place from August to October, the flowers appear in February to March, and the fruit is ripe from June to August. These dates vary slightly according to locality, climate, and stock of plant grown. For example, in Western India suckers are sometimes planted as late as January to March, the plants being liberally watered till firmly rooted. The fruit should be cut with a sharp knife a little before it is fully ripe, and a portion of the stalk retained. In fact, every care should be taken not to bruise the fruit nor to pack an overripe fruit along with others in perfect condition, otherwise fermentation will be set up and the package ruined. The earlier the fruit reaches the market the better the price obtained.

The leaves, as already observed, yield a beautiful soft silky fibre. This in the Philippine Islands is woven into a textile known as *pina*, which some few years ago was in great demand for ladies' dresses in the East. In some parts of India the fibre is worked up into strong, durable, and fine thread employed by the shoemakers, jewellers, &c. But so little progress has been attained with this wonderful fibre, that the explanation of that fact must alone be found in the belief that the textile world does not care to have any new fibres, however beautiful and good they may be. [G. W.]

Pink, a name given to several species of Dianthus, the genus which includes the Carnation and Sweet William. The desirable kinds include: *D. alpinus* (Alpine Pink), a native of the Austrian Alps, with blunt-pointed, shining-green foliage, and deep-rose-coloured flowers spotted with crimson and numerously produced; *D. cæsius* (Cheddar Pink), a native plant, with fragrant rosy flowers, and while it is difficult to cultivate in a border, is quite at home on a wall; *D. chinensis* (Indian Pink), of which there are single and double forms, a variety *Hedwigii* with larger flowers, and a later-growing section known as Imperialis; *D. deltoides* (Maiden Pink), a native plant with pink-spotted or white flowers, of easy cultivation; *D. neglectus* (Glacier Pink), a pink-flowered alpine, of very dwarf tuft-like habit; *D. superbus* (Fringed Pink), which has fragrant flowers, their petals cut into strips for more than half their length. The familiar Garden Pink beloved of cottage gardeners has been derived from *D. plumarius*, a native of Eastern Europe with single purple flowers, now naturalized in parts of this country. Very numerous varieties and forms were produced by the old florists, but many of them have been lost. Pinks are more hardy and dwarf in habit than Carnations. They are propagated by seeds, layers, or cuttings (pipings). The varieties are divided into two sections: Show or Laced and Border Pinks. For the production of large flowers a bed should be made up with good loam, road scrapings, and well-rotted manure. The Sea Pinks are species of Armeria. [W. W.]

Pink Eye.—On the American continent the designation Pink Eye has been given to influenza in horses because the most prominent symptom of this malady is the swollen and inflamed condition of the eye membranes. The term has been introduced into this country also. See art. INFLUENZA.

Piophila casei (Linn.).—Cheese and bacon hoppers are produced from this active little black fly (shown in fig. 5 natural size, 6 magnified), which enters the crevices in cheeses, especially when moist or damaged, to lay its eggs; the maggots from them are white, slender, and taper to the head (fig 1 magnified), and by bending the head to the tail they can spring a considerable distance (fig. 2). They change to pupæ of a bright-chestnut colour (3, 4, natural size and magnified). As these insects breed in farmyards



Piophila casei (Cheese-hopper)

and manure heaps it is impossible to keep them out of cheese-rooms; and from the flies concealing themselves in the cracked cheeses, with the eggs and maggots still more securely situated, fumigating even with sulphur is a very doubtful remedy. The best security is to keep the rinds smooth by scrubbing and greasing the outsides, cutting out the soft parts when affected, and filling the cavities with pepper and butter, covering them with soft paper, and removing all damaged cheeses. [J. C.] [C. W.]

Pipits. — These small perching birds are closely related to the wagtails, and somewhat resemble larks in appearance. They feed on insects, snails, and seeds, and are beneficial to agriculture. Three species require mention: (1) Tree Pipit (*Anthus trivialis*).—Distinguished by its long tail and lark-like song. It is a migrant species, common in England from April to the end of September, but rare in the Highlands and unknown in Ireland. The grass nest is constructed on the ground, and lined with plant fibre. The six eggs are dull blue or grey with brown spots. (2) Meadow Pipit or Titlark (*A. pratensis*).—This partly resident, partly migratory species is distinguished by a white line over the eye and white spots on the tail. The deep grass nest is built in early April on the ground in the neighbourhood of water. It is lined with vegetable fibre. The five grey eggs are spotted and streaked with brown. (3) Rock Pipit (*A. obscurus*).—This sober-hued resident species is common in rocky parts of the coast. Its nest is constructed of seaweed or grass, and lined with feathers or vegetable fibre. The five greyish-white eggs are marked with red-brown spots. Two broods are hatched out in the season. [J. R. A. D.]

Pith Moth. See BLASTODACNA VINOLENTELLA.

Pit Planting. See PLANTING.

Placenta or **Cleansing.** See AFTERBIRTH.

Plane Tree (Platanus) is the only genus of the Platanaceæ family. Its characters are easily recognized by its alternate, palmately five-lobed, simple leaves with tubular stipules covering and hiding the new buds till the old leaves fall off; its globular, greenish-yellow inflorescences in April and May, and its round collections of brown fruits ripening in autumn and attached to slender hanging stems; and its light-coloured bark, which annually flakes off in large scale-like patches and uncovers the newer grey-green bark below. Its leaves are very like those of the Norway Maple, but are easily distinguishable by having the main nerve of the lowest lobe on each side running into that of the next lobe above, while its bark scales off much more freely than that of the Sycamore or so-called Scots Plane; and in the Plane the leaves are alternate, while in Maple and Sycamore they are opposite (in alternate pairs). It is to this free scaling of the old bark containing the older lenticels (then clogged and unable to withdraw oxygen from the air) that the Plane is able to grow so much better than other broad-leaved trees in the smoky atmosphere of large cities, and that it is now the chief tree planted in the London parks, where it grows to a height of 60 or 80 ft. with a girth of 8 to 10 ft. There are two species: the Oriental Plane (*P. orientalis*), indigenous to the Levant and Western Asia, and forming forests in Greece; and the Western Plane (*P. occidentalis*), indigenous throughout North America. In the eastern species the bark scales very freely, the deeply cleft leaves have generally 5 main nerves (seldom 3) and green petioles, greenish-yellow flowers, and 2 or 3 rough seed-balls on each spike; while in the western species the bark scales less freely, the slightly lobed leaves have generally 3 main nerves (seldom 5), the flowers are greenish, and the seed-balls are smooth and usually solitary. But through casual hybridization Plane trees now seldom run true to these specific characteristics. And the result of this is that the variety of the Oriental Plane now common in the London parks and best able to thrive amid city smoke is known as *P. acerifolia* from the resemblance of its leaf to that of the Norway Maple. The wood of the Plane tree, reddish in warm climates, is here yellowish-white, and light (sp. gr. 0·58 seasoned), though hard and of good quality; but in Britain it is only grown for ornament in towns. It grows well on any kind of deep, light, fresh soil, but not on lime or on stiff clay, wind-swept knolls or damp, frosty hollows. It can easily be grown from seed, readily procurable in large quantity and of good quality from the long town avenues of the Riviera, and either sown at once or kept dry and warm over the winter for spring sowing. But layers root freely, and cuttings taken from the one- or two-year-old wood strike easily. The Plane tree stands cutting well, and branches freely when lopped about 12 or 15 ft. up, to form an avenue tree. Around Aix-les-Bains it is pollarded like a poplar. [J. N.]

Plantain, the name given to *Musa paradisiaca*, a tropical fruit-bearing plant allied to the banana (which see). It is also applied to

species of Plantago, a genus of common herbaceous perennial weeds popularly called Ribworts or Rib-grasses, of which only the following are of any agricultural interest:—

1. Broad-leaved or Greater Plantain (*Plantago major*, L.) is a widely distributed wayside and meadow plant, with flowering spikes 3 to 12 in. long; when the seeds are ripe the spikes are much used for feeding canaries and other cagebirds. The leaves are broad, ovate, strongly ribbed, with long leaf-stalks; they are more or less ascending in habit. Where it occurs in meadows and pastures it crowds out the more useful grasses and clovers. From eight to sixteen small black or brown seeds are present in a ripe fruit capsule; these not infrequently occur as impurities in small clover and grass seeds of European and North American origin.

2. Hoary Plantain, or Lamb's-tongue (*P. media*, L.), is a common pest in meadows and pastures, and a nuisance on lawns, where its flat rosette of leaves lies close to the ground and crowds out the finer herbage. The leaves are broad, elliptical, and pubescent, with short leaf-stalks, and the flowering spikes 6 to 12 in. long. Each ripe capsule contains two dark-brown, boat-shaped flattish seeds which are occasional impurities in European clover seeds.

3. Ribwort, or Narrow-leaved Plantain (*P. lanceolata*, L.), is another very common species met with in meadows and pastures throughout Europe, and introduced, like the others previously mentioned, into Canada, the United States, and other countries in clover and grass seeds. The leaves are 2 to 12 in. long, lanceolate, and more or less upright in habit. The spike is ovate or cylindrical, ½ to 2 in. long, borne on a long furrowed stalk. Two seeds are produced in each capsule; they resemble miniature date stones in form and colour, and are very common impurities in badly cleaned samples of red clover and grass seeds. Formerly it was recommended as a useful plant for inclusion in mixtures of seeds for sowing down grassland on loams, especially where grazing was the chief object. It grows early in spring, and cattle and sheep find it very palatable and apparently nourishing. Where abundant, the hay containing it requires careful drying, or serious heating in the stack results. [J. P.]

Plantation Clearing, Cleaning, and Weeding is needed to a greater or less extent in almost every plantation for at least one or two, and usually for two or three years after it is formed. Owing to our moister climate, very favourable to the growth of grasses and herbage, British plantations usually need far more weeding than is necessary on the Continent with its drier climate. In the western parts of the Scottish Highlands, when hillside plantations are formed on old rough sheep pasture, the growth of grasses is so exceedingly strong as to necessitate searching for the lines of plants and freeing them from the weeds that would otherwise choke them. Such operations have there to be carried out twice or thrice a year, and usually for at least two years in succession, until the leaders of the young plants have grown high enough to be out of reach of further danger. But even when such first weedings have been completed, sporadic growth of quick-growing softwoods may also have to be checked. This sort of casual sporadic growth is always worst where Birch, Aspen, and Willow have had to be cleared from the planting area, as the stool shoots and suckers thrown up grow rapidly and soon spread sidewards, interfering with the surrounding plants. And where these softwoods stand to the windward near young plantations, their light winged seeds get scattered over the area and often give a good deal of trouble; for they not only tend to directly interfere with the proper growth of the young crop, but also afford the means of spreading those leaf diseases (*Cæoma*) on Larch, Pines, and Spruces, which have their change of generation (*Melampsora*, &c.) on Poplars, Willows, Birch, and Aspen. In addition to weedings it is sometimes also necessary to clean a young crop by removing 'nurses' from damp spots when no longer required as a protection against frost, or by cutting out weakly young poles. [J. N.]

Plantations intended for timber crops to be worked on business principles should be formed and managed upon some sort of regular plan with regard to formation, tending, management, and ultimate harvesting. As to the choice of trees for planting, the timber crops most likely to prove profitable on land of poor quality are conifers (Scots Pine on dry sandy places, Austrian Pine on lime, Larch on fresh soil with good natural drainage, Silver and Douglas Firs on fresher land, and Spruces, Cypresses, and *Thuja gigantea* on moist soil). Broad-leaved trees require land of better quality (Oak on clay; Beech on lime or chalk; Oak, Ash, Elm, and other hardwoods on loams and mild fresh or moist soil; and Poplars, Willows, Alders, and Birch where the land is wet, but not water-logged). The local market and demand for one or another kind of wood must influence the choice of species to a great extent; but as a rule it is wisest to try to grow the kind of timber for the production of which the given soil and situation seem most suitable. And this, of course, means that wherever the soil and situation show marked differences, different kinds of trees should be planted, with the result that the plantations will become mixed woods formed of larger or smaller groups of trees suited to the given local conditions. These same considerations also mainly determine the amount of draining, clearing of surface growth, soil preparation, the method of planting that can best be adopted, and the number of plants per acre, and thereby practically fix the total cost of planting per acre. Whether it will pay best to raise seedlings and transplants in one's own nursery or to get either seedlings or transplants from elsewhere, and whether spring or autumn planting is best, depends on the extent to be planted annually and on the amount of labour obtainable locally, although, other things being equal, it is usually best to plant broad-leaved trees in autumn and conifers in spring. As regards soil preparation, wet land should be drained at least a year in advance, rough moorland has to be cleared and burned, moorpan has

to be trenched to break through the impervious subsoil, and shifting sands have to be fixed before planting can be done with reasonable expectation of success. For a very light or sandy soil, notching at 3 or 3½ ft. is certainly the quickest and cheapest method of planting; but on stiffish land, 'hole-and-plug' or spiral spade pit planting at about 4 ft., either with ball plants raised from the nursery with circular spades or with naked plants, is the more likely to prove successful, though it costs more (see art. on PLANTING). The poorer the land, the closer should the plants be set; and the better the land, the sooner the plantations will establish themselves and grow up to form a thicket. But the best distance for planting, or the number of plants needed per acre, depends both on the soil and the kind of tree, and also on the prospect there is of being able to dispose profitably of young thinnings. Wide planting usually means expensive cleaning and weeding in young plantations; but there is no use in incurring the heavier expense of planting at 3½ or 4 ft. (3556, 2722 per acre) if 4½ or 5 ft. (2151, 1742 per acre) would practically answer equally well, unless a good local market for early thinnings promises a fair return. So also with regard to the purchase of plants or the maintenance of a permanent home nursery, with or without one or more temporary nurseries nearer the planting areas. And certainly it is desirable that young plants (especially conifers) should be acclimatized to the greatest extent possible before being planted out, as otherwise they are much less able to resist late frosts and fungous diseases. If mixed plantations are to be formed, it is far better to plant in groups according to soil and situation than to intermix the different kinds of trees with stencil-like regularity (see art. on MIXED WOODS). The cost of planting is very much greater than formerly. It may now be roughly estimated as costing, inclusive of soil preparation and plants, from about £2 to £3 an acre for notching, and from £4 to £6 for pitting with naked plants—though, wherever practicable, the German method of pitting and ball-planting with circular spades on stiffish soil is almost as cheap as notching. Wherever obtainable, the shelter of woods and plantations should be taken advantage of when drawing up a scheme of planting extensively, as young plantations always thrive best when screened from strong winds. Plantations seldom succeed in establishing themselves without needing a certain amount of beating up to fill blanks caused by late frosts, &c.; and when old rough pasture land on hillsides has been enclosed and planted after the sheep are taken off, there is usually (and especially in the damp climate of the western Scottish Highlands) a very strong and rank growth of coarse grasses and other weeds, which necessitates several weedings during the first two or three years, till the young plants get their leading shoot up well above the danger of being smothered and overlaid by the grass. When once this danger is over, careful inspection of all young plantations should be made to see that fungous disease is not obtaining a foothold from which it would be likely to spread, and that insects are not attacking the young plants. But when they grow up and form almost impenetrable thickets, no further operations are called for until the first thinnings become necessary, usually between fifteen and twenty years of age, according to the kind and quality of crop, the number of stems per acre, &c. The given local conditions as to crop, soil, situation, and the intentions of the proprietor determine, in fact, when and to what extent the first and all the subsequent thinnings have to be carried out; and to attempt to lay down general average figures as to the amount to be cut out, its net local value, and the number of stems that can best be left standing per acre, would only be misleading, as they vary so greatly for different localities and for each kind of tree crop, pure or mixed. From a sylvicultural point of view, however, both in the early and in all later thinnings or partial clearances with or without underplanting, the principle should be carefully adhered to, in that the thinnings in young woods should not be heavy enough to induce an unnecessary amount of branch formation interfering with the growth in height and depreciating the quality and value of the bole as timber, and that the thinnings in older woods should not break up the leaf canopy so far as to risk the deterioration of the soil through unnecessary exposure to sun and wind. Where heavy thinnings and partial clearances are made among light-demanding tree crops, soil deterioration can only be prevented by underplanting (*e.g.* Oak with Beech or Hornbeam, Larch and Pine with Silver Fir), though such measures are not usually practised in Britain, and may seldom prove directly profitable. But it should be borne in mind that soil deterioration means a loss in capital, for it diminishes the market value of the land for growing timber. [J. N.]

Plant Breeding.—The creative breeding of plants and animals is only in its infancy. Many of the world's leading crops, as wheat, cotton, maize, potatoes, apples and other fruits, have been greatly improved by plant breeders. Still other great additions have been made to production by introducing plants from one region to another. And while there are many wild forest, fruit, and forage plants which it is not practicable to improve by breeding, yet the greater bulk of our production comes from cultivated plants which have been improved by selection and crossing. It is estimated that at least 10 per cent could be added to the aggregate value of the world's plant and animal products by more general attention to breeding.

METHOD OF PLANT BREEDING. — Speaking generally, the plant breeder first secures suitable land and other facilities for growing and testing varieties. In the next place, he selects those available varieties which promise to best serve as foundation stocks for improved forms. He tests these new varieties not only on the breeding grounds, but also in other sections of the general region for which he is to produce new plants. In many cases he finds varieties already established in the region which at once serve better than any brought from a distance. If varieties thus secured and tested are found

to be superior, they are not only chosen as foundation stocks from which to make better varieties, but they may also be at once distributed for wide practical use by growers. Once one or more varieties are found which best meet the required conditions, these are used as bases or foundation breeding stocks.

As to methods of procedure in creative breeding, species divide themselves into three classes. In the first class are species like the apple and strawberry, from which clonal varieties are made by vegetative reproduction. A clonal variety is produced from a single seed simply by cutting the plant into pieces or clons, each piece, scion, graft, bud, or offshoot of which grows its own roots and stems. The breeder plants a large number of seeds under uniform conditions, that he may have a large number of seedling individuals so as to test the value of each as a parent of a clonal variety. Many of the resulting seedling plants, if small, are discarded. In case of apples and some other fruits, the more promising seedling plants are allowed to fruit; or clons are cut from them and grafted on older plants, to secure earlier fruits. Finally, cuttings, buds, runners, or other form of clons are separated from those seedling plants of greatest promise, and new clonal plants are grown from each very promising mother plant. The average of these are compared, so as to decide which of the respective seedling plants is best. Thus, the one out of thousands which shows peculiar value along a desired line is discovered and the rest are discarded. Superior varieties are then easily multiplied, as by means of cuttings, buds, grafts, or layers. There is, furthermore, no other trouble in keeping the variety pure, except to avoid wrong labelling.

In the second class are species, like wheat and barley, which are self-pollinated, that is, each floret is fertilized within itself, no pollen coming from other plants. New varieties of these species, as with clonal varieties, are produced from single mother plants. The heredity of each plant of the entire variety is but an identical part of the heredity of the mother plant. Thus in a group of original seeds each becomes an inheritance unit from which the breeder works. To secure those mother seeds with best breeding power, he chooses a large number of good seeds, perhaps ten thousand, preferably selecting them from good heads, or perchance selecting them from the grain bin. These ten thousand seeds, as of wheat or barley, are so planted that each resulting plant is given the same space and the same opportunity as each other plant. In wheat breeding the grain may be planted one seed in a hill, 5 in. apart each way. When the resulting plants are ripe, by cutting out all the weaker plants those which appear best, say five hundred, are secured. By shelling out the seeds and weighing, and also judging them as to quality, we can easily obtain the data for selecting down to that one hundred which yield the most value per plant.

But the vital breeding test begins in the next generation, when one hundred seeds from each of these one hundred chosen wheat mothers are so planted in hills 5 in. apart each way as to give all an equal opportunity, and so that the average value of the progeny of each of the respective mother plants may be determined. When ripe the plants in each of these groups are counted, harvested, and the grain is threshed out and weighed. By dividing the weight of the seeds of each of the new strains by the number of plants harvested, the figure given is an index to the breeding power of the respective mother plants. This 'centgener' test (from the Latin words *centum* and *genera*), sometimes called ear-to-row test, continued for three years, gives averages of values of the progenies of the hundred mother plants respectively, which express in the simplest numerical terms the relative breeding powers inherent in the seed.

An occasional variety stands out showing a strong tendency of exceptional projected efficiency in the direction of producing heavily and of good quality. Thus, usually, the product of all but half a dozen mother plants showing highest breeding value can be discarded. These half dozen new varieties are then tested in field trials in competition with the parent varieties and with any other promising kinds which are in the competition for distribution. These field trials are often continued for three consecutive years, and in two or more locations. The average yields, qualities, and general acreage values are then compared, and any new variety which has exceptional breeding power is thus found. The new self-pollinated variety may be kept pure nearly as easily as the clonal variety, multiplied, widely tested in the region in which it may do well; the territory and soils to which it is adapted may be determined; and it may be rapidly multiplied and disseminated for wide general use by growers.

In the third class are species in the case of which insects or the wind, or both, carry the pollen from one plant and fertilize another. In these species, varieties cannot be made by means of seeds from single mother plants. Here, as a rule, the variety must be built up from a group of foundation mother plants, and making the network of heredity too simple by basing it on too few foundation individuals is not always safe. This makes the problem much more intricate. While the variation may be greater in species of this class, the discovery and segregation of desirable strains is more difficult. Mistakes in methods of breeding may even result in varieties with diminished values. It is not difficult to make the mistake of following a few non-essential qualities and ignoring some of the characteristics most vital to improvement along economic lines.

The testing of introduced or newly bred varieties of open-pollinated species presents many difficulties not met in the first two classes. But even with these species effective methods are being devised, and the marked improvements already made in maize will be followed also, no doubt, by effective methods of improving the clovers, timothy, alfalfa, and other species in the case of which the wind and insects effect constant cross-fertilization.

There are some species in which both the clonal and the seminal methods may both be

used in centgener tests in determining the value and breeding power of mother plants, as in timothy and strawberry. In annuals, like corn, only the centgener, or ear-to-row, test can be used. And where the new variety must be propagated by seeds, as in timothy, the clonal test can be used only incidentally. Here the centgener test differs from this form of test in species where clonal or self-pollinated strains are made. There the heredity of only one parent plant is used, and the successive annual centgener tests and the field tests hark back to measuring the heredity of the one parent seed. In open-pollinated species many original parents are tested by the centgener method, and a number of those showing the strongest breeding power in the desired direction are secured, and their characters allowed to blend by cross-pollination. Where practicable a portion of the seeds of the original ear is kept, rather than to use the cross-fertilized seeds of the progeny of the chosen parent plants. Thus are secured seeds as true to kind as were the seeds used in the original centgener test. And the seeds of a number of the plants proving the strongest breeders in the desired line thus secured, are so planted that cross-pollinating may take place only among plants proven to be efficient. From among the progeny thus produced, by testing large numbers a limited number with high breeding efficiency may again be secured. Thus may the operation be repeated indefinitely, sometimes, if deemed necessary, bringing in new stocks from the original variety and at least testing them out. Thus are secured strains somewhat narrowly bred, which may be tested in field trials; and finally those which yield the largest values per acre may be disseminated. The above bare framework of a method of breeding open-pollinated plants is capable of innumerable modifications and refinements.

Selective breeding, however, is only one of the important parts of creative breeding. As will have been observed, selective breeding takes the species or variety as it is found and ferrets out, segregates, tests, multiplies, and distributes the best strains there found.

Hybridizing.—A more radical though a more difficult method, consuming longer time, is hybrid breeding. In hybrid breeding, selection is quite as important as in breeding by selection alone. Hybridizing, however, prepares the way for still more selection, gives opportunity for wider selection, creates new forms and new potential values to be selected. By hybridizing, the strong units of two or more species or varieties may be brought together, and the weaker units eliminated by selection. By selection the stronger units which came into the hybrid mixture are segregated out and thus are made hybrid strains. In species where clonal and self-pollinated varieties are made, the selection of hybrid varieties is comparatively simple. But in open-pollinated species the selection of hybrids is complex, as shown above in selective breeding from non-hybrid foundation varieties. In either case the more complex hybrid stock takes the place of the ordinary or commercial variety or the native species. Forms and values new to the plant world are created.

The accumulating evidence shows that in most lines of breeding the very best strains occur at very infrequent intervals. Thus in apples or wheat it may be necessary to test the value of tens of thousands of individual plants in order to secure one plant of sufficient excellence in its power to project its individual values into its progeny to produce a valuable new variety. The necessity of using large numbers needs to be recognized as one of the great laws of breeding.

Economic plant production in every locality demands that for that locality at least the staple crops shall be bred in reference to the soil, climate, and other local conditions. While no doubt the larger part of the money used in creative breeding should be employed by private parties or by non-public organizations, yet there is a large portion of the work which can best be done, and which will only be done, by public departments of agriculture and experiment stations or other large institutions. These institutions alone have the means, the workers with long tenure of office, and the other facilities necessary to work out many of the scientific problems, and to devise methods for breeding many kinds of plants. The United States Department of Agriculture and many of the forty-eight State experiment stations are taking up this work extensively, as also are similar institutions in other countries. Private laboratories, universities, and other endowed institutions are directing more and more energies to studying the science of heredity and the more scientific methods of breeding.

One of the first established and more typical of the plant-breeding establishments in a State experiment station in America is that at St. Paul, Minnesota. Here twenty years ago were collected the best available varieties of wheat, oats, barley, rye, flax, maize, clovers, and other forage crops; also the best varieties of apples and other fruits suited to a rather cold country. Some hundreds of acres are now used on the central experiment farm and on several branch station farms for the smaller nursery breeding plots, and for the testing of varieties in this State, which is approximately 200 by 300 miles in area. It has been designed to have eight or ten regular branch stations, with numerous minor trial stations throughout the State. There can be determined those few very best kinds which should be widely distributed for use, and for the final and crucial tests under the hands of the actual growers and consumers. A system of public experiment farms covering the entire country is thus a necessity, to test at least those introduced and newly bred varieties of the leading staple crops which are competing for a place in the great acreage of the fields of the farmers.

Organizations to encourage the study of heredity, and methods of breeding to promote the work of creative breeding and the dissemination and production of superior pure-bred plants and animals, are being developed. The International Genetics Conference originated in England in

1899, and the American Breeders' Association, which was suggested by the first Genetics Conference, then called Hybridizers' Conference, are successful manifestations of the new interest in scientific work in relation to the breeding of plants, animals, and men. The two reports of the Genetics Conference of 1899 and 1907, and the five annual reports of the American Breeders' Association, contain the best published body of knowledge on heredity and breeding now extant. [W. M. H.]

Planting Forest Trees may take place either with naked seedlings taken from the seed-beds at two years of age, or with older transplants (usually two-year-two) taken from the nursery lines either naked or with balls of earth attached to their roots. In planting with two-year seedlings the plants are generally notched or slit-planted by making spade-cuts in L, T, or H shape and then slipping in the plant, withdrawing the spade, and treading down the turf again. Plants with balls of earth are usually pitted or mound-planted (see MOUND PLANTING). Notching is the cheapest form of planting, as a man can average about 1000 a day (or costing about 15*s.* an acre, at 3 ft. apart, for labour alone). But it is only suitable for a light friable soil; on stiff land, root malformation to a greater or less degree is certain; and insects and fungi are then more likely to attack the plantations. Pit-planting with transplants in holes of about 9 in. in width and depth gives the plants a better chance, but costs more. The minimum cost of opening 9-in. pits is 4*s.* 2*d.* per 1000 (Benmore, Argyllshire), and of planting about the same; and at 4 ft. (2722 per acre) this amounts to 22*s.* 6*d.* per acre, plus cost of plants. But the total cost usually varies from 50*s.* to 80*s.* per acre. On stiff soil it is the best method.

It is best to plant the young plants singly, as wisps of three or four seedlings or young transplants seldom prove satisfactory. When planted, neither seedlings nor transplants should stand deeper in the soil than they have stood in the nursery. Deep planting is bad for all kinds of plants, but especially for conifers, and among conifers especially for the shallow-rooting Spruce, which then endeavours to throw out a new lateral root system nearer the surface. If planted too deep on a friable sandy soil, the plants may in a short time be able to adjust themselves to their new environment; but if the soil be so stiff as to prevent the free circulation of oxygen, then the root system gradually becomes suffocated through being deprived of a sufficiency of oxygen. Under any circumstances the moving of trees or shrubs from one place to another is bound to create a certain amount of physiological disturbance, the power of overcoming which varies in different kinds of trees. And if in lifting the plants from the nursery lines many of the rootlets get damaged, then it is desirable to trim the foliage to a slight extent with the pruning-shears, so as to try and restore something like the previously existing normal balance between imbibition and transpiration. Such trimming should, however, be avoided so far as possible; hence the use of small plants and simple planting methods is preferable to larger plants and costlier methods of planting, if the latter are not rendered necessary owing to strong growth of weeds or other reason. Healthy plants may with care be transplanted at any time of the year; but physiological disturbance in the organism is reduced to its minimum if the removal take place either just after active vegetation has ceased in autumn, or just before it recommences in spring. But as root growth goes on to a slight extent in broad-leaved plants though not in conifers during the winter period of rest, autumn planting is (other things being equal) best for broad-leaved kinds, and spring planting for conifers (thereby avoiding disturbance in connection with winter storms and with foliage transpiration of the evergreen kinds during bright sunny weather in winter, and somewhat retarding the flushing of new foliage when frost is most frequent in spring). Wherever the supply of suitable labour is limited, however, planting work over any extensive area practically goes on right through from autumn till spring whenever the weather is open and favourable. In spring planting it is best to plant the warmer exposures before the colder hollows and northern aspects, and to plant first of all the kinds which flush their foliage earliest (Larch, Birch, Elm, Chestnut), then to set out the other deciduous trees, and to plant the evergreen conifers last of all, as they mostly stand transplanting well even after their new foliage begins to flush (not Austrian Pine, however, which generally transplants badly, though sometimes best in July if that be a wet month). The cost of plants and planting may vary greatly from about £2 to £6 an acre, according to amount of soil preparation, size of plants and number per acre, method of planting, local climate, &c.; but the report of the Royal Commission on Afforestation (1909) estimated it at about £6 on the average. [J. N.]

Plant Lice, the popular synonym for those insect pests known as the Aphides or Green Flies. See art. APHIDES.

Plants, Diseases of.—Although disease in plants was observed as far back as records exist, yet plant pathology is a comparatively modern study and owes its present position to the labours of a few specialists of the last generation. The study of disease involves a knowledge of the normal healthy plant, its parts, its functions, and its many relations to environment or external conditions. Disease sets in when these normal conditions are interfered with.

The causes of disease differ widely, and it is not always possible to separate one cause from another, but the following is a convenient grouping:—

A. Diseases traceable to factors in the environment:

(*a*) Parasitic plants (see FUNGI and DODDER).

(*b*) Animals (see ENTOMOLOGY and other articles).

(*c*) Unhealthy conditions arising from the soil, the atmosphere and its pollutions, from frost or heat, and other non-living factors (see SMOKE DAMAGE TO TREES).

B. Diseases due to internal causes and not directly traceable to environment (see 'Chlorosis' in art. GRAPE VINE and also art. GUMMING).

That it is difficult to separate one cause from another is evident in many diseases; a perusal of the art. LARCH DISEASE will show that frost, larch aphis, and larch fungus are all concerned.

In this Cyclopedia the principal facts about symptoms, causes, and treatment of diseases will be found by looking up the name of the plant, or in special articles on injurious insects and parasitic fungi. [W. G. S.]

Plants, Nature and Functions of.—This subject is treated under the following main heads:—(1) Introduction; (2) the Root; (3) the Shoot; (4) Cellular Structure; (5) Respiration; (6) Propagation and Reproduction.

1. INTRODUCTION.—Botany is the science that comprehends all our knowledge of the vegetable kingdom, all the knowledge that relates to plants. At the basis of all plant culture, whether culture in fields (agriculture), or in gardens (horticulture), or in woods (sylviculture), or even in vats (brewing), there lie certain broad general rules or principles which it is advisable to know, in order to control more rationally, and therefore better, the plants which we rear and breed. It is advisable to know also the points of strength and of weakness in certain cases, in order that we may be better able to combat and get rid of those pestilent plants which as weeds interfere with our crops, which as disease producers and parasites render our crops unhealthy and diseased, in some cases even killing outright. A sketch of the chief botanical principles involved in the practice of agriculture is all that will be attempted here. This sketch must, of course, be very incomplete and very brief. Certainly 'a little knowledge is a dangerous thing'; and this is a very good reason for knowing a little more, and so making the dangers of ignorance less.

All agriculturists know that to get a potato plant we must sow either a part of a potato plant or a potato seed from the 'plum'. The same applies to all plants without exception. If a weed appears mysteriously in our corn, or if grasses spring up which we did not wittingly sow, or if a fungus disease breaks out among our crops, we are certain in every case that a bit of the weed, or of the grass, or of the fungus, or it may be a seed or a spore of the plant, must have been present somehow or other. This invariable rule in the terse language of science reads: '*There is no such thing as spontaneous generation*'. A bit of the plant, whether large enough to be seen by the naked eye, or so minute as only to be seen by the highest powers of the microscope, must have been present somehow. In knowing all the details connected with this 'somehow' lies the practical importance of a minute scientific knowledge of agricultural botany.

Every plant now existing must have a body capable of doing two things—(1) it must be capable of maintaining itself; (2) it must be capable of producing successors; in other words, the body of a plant is composed of (1) *vegetative organs*, and (2) *reproductive organs*. Take, for example, an apple tree in full bloom, and remove with a pair of scissors all the blossoms. All that is left, after flower removal, constitutes the vegetative organs for looking after the maintenance of the individual; all that has been removed by the scissors—a trifling part, so far as weight is concerned—constitutes the reproductive organs for looking after the production of successors.

At times the main object of the agriculturist is to get vegetative organs in excess, at other times to get reproductive organs in excess; and according to his purpose, the knowing agriculturist chooses his seed large or small, from this locality or from that other. He knows that the amount and quality of the vegetative organs depend upon his choice of seed, and that the amount and quality of reproductive organs also depend upon his choice. The productions of cold climates tend to have more vegetative organs, those of warm climates more and better reproductive organs and seeds. Take flax-growing, for example; sometimes the plants are grown for vegetative organs and fibre—then, of course, the best seed comes from cold climates, such as Riga; sometimes the main object is seed production, and now the best seed comes from a warmer climate. Knowledge of details connected with proportion of vegetative to reproductive organs lies at the root of our choice of seed and of our change of seed.

The vegetative organs of a green plant have to do two things: (1) to get into contact with earth, (2) to get into contact with light and air. To secure contact with earth, one part of the plant body grows down into the earth in obedience to the law of gravity, while another part grows up into the air and light in defiance of the law of gravity. The downward growing part is the *root*, the upward growing part the *shoot*. The vegetative body of a plant is thus composed of (1) root, (2) shoot.

2. THE ROOT.—To secure anchorage and contact with earth most intimate and most extensive, the first root forms outgrowths on its sides in various directions, younger and finer, of course, deeper and more deep than the root which gave them birth, but not otherwise different. These side outgrowths are called *branch roots*, which in turn repeat the branching process in various directions, and so on till every nook and corner of the soil is vertically and horizontally occupied by the finer and finest branches, which are often called *root fibres*. In this way the plant gets anchored in the earth in that position which enables it to thoroughly exploit from the surface and from the depths certain raw materials which it requires.

What raw materials does the root require to import into itself from the soil? At first it might be supposed that one plant wants this and another plant something else. But careful investigation shows that '*all green plants want essentially the same substances from the soil*'. This truth is apt to be hidden from us by the circumstance that plants show much variation in composition when subjected to chemical analysis. These chemical analyses, however, when rightly interpreted, do not teach us that plants *require*

from the soil different substances, but that different plants use some larger, some smaller amounts of the same substances. Plants, like ourselves, can be 'hard up', and may be handicapped for want of enough of this, that, or the other stuff necessary to meet their needs—necessary to keep them at their best, and it is the aim of high-class and profitable agriculture to supply by manures the essentials which are adjudged deficient.

The principle that all green plants want essentially the same stuffs from the soil is the very principle upon which scientific and practical manuring alike proceed. We always aim at providing the plant with a sufficiency of *nitrogenous and phosphatic manures*, with *potash and lime compounds*. Whether the nitrogenous manure takes the form of nitrate of soda, or sulphate of ammonia, or soot, or whatever else it may be, is a matter of cost and expediency; all are agreed that plants want nitrogenous manures in some shape or form. Whether the phosphatic manure takes the form of ground bones, mineral phosphate, superphosphate, or basic slag, is again a matter of cost and expediency; all are agreed that plants want phosphatic manures from the soil. The same applies to potash and lime. Wherever we see a green plant growing, whether on a stone wall or in a fertile field, there, we may be certain, are available supplies of nitrogenous and phosphatic salts, potash and lime compounds, whatever else there may be besides.

The principle that 'all green plants want essentially the same substances from the soil' becomes quite clear by the method of 'water culture'. In this method, distilled water is taken as the basis, and this water is mixed with minute quantities of nitrates, sulphates, and phosphates of potash, lime, and magnesia, along with iron in the form, it may be, of an old rusty nail. With roots submerged in this watery solution, plants can be grown in perfect health. It is found by experiment that if any of the ingredients above mentioned are wanting, the plant at once betrays the want by becoming unhealthy and abnormal. The substances which the plant requires from the soil are, then: nitrates, sulphates, and phosphates of potash, lime, and magnesia, plus a small quantity of iron. Practical agriculture ignores the necessity of sulphate, magnesia, and iron, and the practical reason for ignoring the necessity of these in a complete manure is that, as a rule, there is already in the soil abundance of available sulphates, magnesia, and iron compounds. To sum up, chemical analysis shows that substances other than those mentioned as *essential* are present in the plant; water culture, in turn, checks chemical analysis and shows that the other substances are merely accidental, and not at all necessary to fully meet the requirements of healthy growth.

The substances that plants remove from the soil are called in a rough-and-ready way 'plant food'. This name immediately raises the question—What is the specific use to the plant of each of the stuffs taken in?

Some of the water that enters the plant from the soil has to be combined with carbonic acid from the air, and this combination can only take place under the stimulating influence of light—whether sunlight or electric light is a matter of indifference to the plant. This purpose of water is not to feed the plant, but to be converted into a foodstuff, namely sugar or starch. It is misleading, then, to call water by the name 'plant food', for it is in reality a *food-making material*.

The nitrates, again, which enter the roots are used for a specific purpose. They enter into chemical union with varying quantities of sugar or starch, and ultimately are transformed into albuminoid foodstuffs. Here we see, again, that nitrates are not 'plant food', but only food-making materials. The same applies to phosphates. We thus come to the conclusion that the substances removed by plants from soil are used, not as foodstuffs, but as *food-making materials*.

The next question is: How are these food-making materials transferred from the soil to the inside of the plant? The practical importance of this question is that it throws light on those conditions which must be secured, if the plant is to be thoroughly efficient and smart at this business of using the soil. The first point to notice is that the root must secure contact with the stuffs. All know that the roots cling to earth, and the most extensive and intimate contact is secured by innumerable root branches bearing multitudes of fine hairs—root hairs they are called—which clothe the young parts of the roots. We can see these root hairs quite easily on sprouted oats grown in damp blotting paper between two saucers. Now there are no holes or pores of any kind, either on the surface of the root or on the hairs, and yet the stuffs outside have to find an entrance. The process of entrance is easily understood. If we take a pig's bladder, fill it with thick syrup, tie it up tight, and place it in a tub of water, the whole bladder soon swells up, for the water outside passes through the bladder and mixes with the syrup within, although there are no holes and no pores for entrance. This process of entrance through a membrane without pores is called *osmosis*. The two important points to notice are: (1) the warmer the water outside, the faster the bladder swells; (2) the thicker the syrup, the faster the bladder swells.

The plant root, indeed, acts as an osmotic machine; each one of the multitude of root hairs acts like the pig's bladder, and absorbs material from the surrounding soil by osmosis. Like the bladder, too, the root is more efficient, and acts quicker (1) if the soil is warm, (2) if the solution in the hair is dense.

The plant root is called upon to take in from the soil more than solutions of soluble stuffs—that is, stuffs soluble in water. Land that has been under grass for generations, with water draining through it, would be exhausted of soluble matter unless some provision existed for converting the insoluble soil particles into soluble form. The question reduces itself to this: How can a plant root utilize a particle of bone, which certainly is not soluble in water?

The answer is, that the root has the power of manufacturing acids, which exude to the surface of the root and to the surface of the root hairs. These acids attack the bone particle, render it soluble, and the solution of the bone is now absorbed by the osmotic hair. It is quite easy to convince oneself of the solvent action of roots on insoluble substances—that is, on substances insoluble in water. Take a flower-pot, and, in the earth, halfway from the bottom, place horizontally a polished plate of marble. Sow some seeds of Indian corn so that the roots, growing down into the pot, must come into contact with the marble plate. It will be found, on removing the earth and the plants from the pot, that the roots of the Indian corn have, as it were, chiselled out the marble plate, and that they actually cling to the marble.

Plants are not equally gifted with this solvent power. Those that specially excel are the cereal and fodder grasses, clovers, beans, and vetches; whereas root crops, such as turnips, potatoes, and mangels, require large supplies of soluble stuffs, such as are provided by dung and soluble artificial manures.

We now begin to get a glimpse of what a fertile soil really is. It is a soil in which the roots are comfortably housed—so circumstanced that they can get all they require, and can display their full powers as absorbing machines. The main conditions for this display of power are warmth in the soil and dense sap within the root.

Consciously or unconsciously, the principles underlying root action guide, to a certain extent, the rotation of crops which the farmer adopts. For, if he cultivates heavy land, and has to exploit the multitude of insoluble particles therein, he devotes more years of the rotation to those crops whose roots excel as solvents; whereas if his land is light, and poor in those insoluble particles required by the plant, he devotes more attention to the root crops, and uses more dung and artificials.

3. The Shoot.—The mechanism which the green plant uses for thickening its sap and for forming stuffs fit to nourish is that part of the vegetative body of the plant called the shoot or 'shaw'. The shoot is composed of two things: (1) stem, (2) foliage leaf, and nothing more. At first when the shoot is young we cannot see the stem, for it is very short and wrapped in encircling leaves as yet unfolded. At this young stage of growth, the whole shoot is called *bud*. A bud is thus the name for a young shoot or 'shaw' before the stem has lengthened out, before the leaves are enlarged or unfolded. On a potato tuber, for example, the buds are in clusters called 'eyes', and each bud of the eyes is capable of unfolding and becoming a shoot or 'shaw'.

The shoot, which is, as it were, the great workshop of the plant, has to acquire a large and extended surface, so as to secure a sufficiency of the light and air around. This it does, like the root, by branching out. The branches start in the angle between leaf and stem. When young they are in the bud state; but later these buds develop, and ultimately become leaf-bearing stems like the shoot which gave them birth.

We have now to consider how the shoot acquires a supply of minerals sufficient to carry on its various manufacturing processes. For this supply, a set of carrying pipes (or vessels) is laid down in the plant. These pipes are arranged in bundles and extend right up from the root, through the stem, and bend out into the leaf. They are easily seen on an old rotten cabbage stock, where the soft parts have been eaten away, and the hard parts, including the pipes, are left behind undecayed. The bundles of pipes, when in the leaf, are called 'veins'. All these pipes co-operate together and import the mineral water from the soil through the root and stem and into the 'veins' of the leaf. In the leaf a condensing process is carried on.

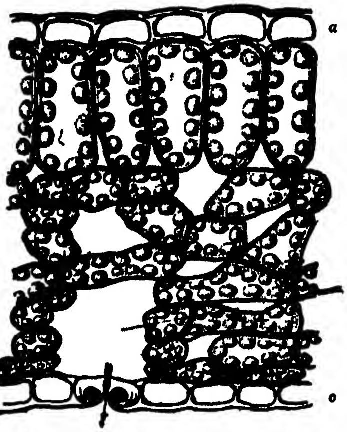


Fig 1.—Diagrammatic Section of Leaf

a, Upper epidermis *b*, Air space in which water vapour collects. *c*, Lower epidermis.

This is accomplished by letting the water escape in vapour form through spaces and pores designed for this very purpose. Now, what does the plant gain by letting the bulk of the water escape? The gain is this. The plant has a thousand times more soil minerals at its disposal than would be possible if the water vapour had not escaped. The case here is like that of the river Jordan and the Dead Sea. The river brings in a small portion of material in solution, and the bulk of the water brought in escapes from the Dead Sea in the form of vapour, leaving a charge of minerals behind. So the river Jordan goes on pouring in its water, and yet the level of the Dead Sea remains unchanged. But the water left has become salter, and solid deposits have even formed at the bottom. So is it with the plant. The process whereby large supplies of minerals are got into the shoots, and placed at the disposal of the plant, is called *transpiration*. Some idea of the importance of this transpiring process is got when we consider that one acre of cabbages gives off six tons of water in twelve hours. All know how crops vary with season, and season affects plants more or less according as it affects transpiration more or less. The illustration

shows a section of a leaf-blade under the microscope, and the large amount of space within for holding water vapour. An arrow has been placed in one of the pores through which the water escapes from the plant to the outer air.

The shoot of the plant has not only to secure an adequate supply of minerals, but it has to put that supply to a proper use; for the minerals are only means to an end, and that end is, in the main, conversion into *foodstuffs*. The important point is that the plant cannot turn the soil-derived minerals to use, unless it has prepared beforehand a supply of sugar and starch to combine with them. How is this sugar supply to be obtained? No sugar comes from the soil, and certainly none from the air. The sugar has to be manufactured inside of the plant from simple stuffs that are not sugar. The stuffs used are two—a liquid and a gas. The liquid is water, derived from the soil; and the gas is carbonic acid, extracted from the atmosphere around the shoots. Air contains only 3 gal. of carbonic acid in 10,000 gal. of air. Therefore, to get an adequate supply of the gas, the plant must be specially smart at separating this small quantity of carbonic acid from the very large quantity of nitrogen and oxygen with which it is mixed up. It is plain that an extraordinarily large quantity of air must pass through the extracting machinery to meet the demands of the plant. The machinery for extracting and utilizing the carbonic acid is easily discerned, because it is always impregnated with conspicuous green colouring matter. Indeed, the greenness of his crop is a rough-and-ready indicator to the farmer of the health and activity of the plants which he is growing. He rightly regards any discoloration, or any deficiency in the green, as a certain sign of inactivity or ill health, just as the doctor looks upon discoloration of the tongue of his patient. The air required enters freely, not by osmosis, but through the numerous small pores in the skin of the green shoot. It then passes along open spaces within the plant, and ultimately reaches the green bodies which absorb the carbonic acid gas and let the other constituents of the air go free. The green bodies are now, as it were, little sponges, charged with water and carbonic acid. If light is present, the water and carbonic acid cease to be such, and are changed into sugar and a waste product which escapes, namely oxygen gas. All the sugar in the plant is made in this way from carbonic acid and water. When necessary, the plant can take this sugar and transform it into a substance insoluble in water, namely starch. All the starch in a plant is made by transformation of sugar. In point of fact, the plant is continually changing from sugar to starch and from starch to sugar according to its needs.

It is the light that supplies the plant with power to work its green machinery. Without light, the plant is powerless to make addition to its solid organic substance. Just as the photographer uses the power of light to change the substances spread out in a film upon his plate, so the plant uses the same power to work the green machinery spread out within its shoots (or shaws). If we keep the light away by shading the result is deficiency of sugar in the plant and more or less starvation, however fertile the soil may be. This principle is applied to weed-destruction, and more especially to perennial weeds. A cereal crop is sown thick so as to shade the weeds beneath, and as soon as possible after harvest the weeds, 'drawn up' and lean and weak, are attacked and removed. It is chiefly to secure a due supply of light that turnips are thinned and weeded, that potatoes are sown at certain distances apart, that corn is sown at a certain rate per acre, and so forth. It is by breaking the law of light-requirements that pastures often fail when too thickly seeded, so that one plant shades the other overmuch—mutual destruction is the inevitable result. The same applies to seasonal variations in crops. They cannot be expected to display the same activity, and to yield heavy crops, in dull seasons, when the supply of light is abnormally scant. There is much variation in the amount of light demanded by different kinds of plants. Lucerne, for example, does not grow in Scotland under a grain crop; and red clover is killed off when the grain crop is too thick, especially if followed by a rich growth of Italian rye grass. It is perfectly plain that the working agriculturist cannot have too much accurate knowledge of the light-requirements of the various plants with which he deals—he may easily have too little.

The sugar produced in the leaf is distributed through the plant, some of it going to the root and root hairs. This being so, it is easy to understand how the activity of the root and of the shoot go hand in hand. In the bladder experiment mentioned in connection with the working of the root, we noticed that the rate at which the bladder absorbs the water and swells up depends upon the strength of the sugar solution within it. Now the shoot removes water from the root, and gives in return a supply of sugar, thus keeping the absorbing power of the root at a maximum by preserving the proper density of the sap in the root hairs.

We have now to see how the plant makes use of the minerals imported from the soil and accumulated in the shoot. It converts them into the albuminoid foodstuff, the essential constituent of beef and eggs. The materials used for this manufacturing process are three, namely, sugar, nitrates, and sulphates. The sugar ceases to be sugar, the nitrates cease to be nitrates, the sulphates cease to be sulphates, and in their place the albuminoid appears. This very complex compound is not produced all at once but gradually, the compound of the sugar with the minerals being at first more simple. In forced rhubarb, for example, both sugar and minerals are present, the sugar being produced from the starch previously stored up in the rhubarb stock. But, in this case, the combination of sugar with the minerals produces a much simpler compound than full-fledged albumin. In rhubarb, in asparagus, and indeed in all forced plants, where the sugar is comparatively scanty, the albuminoids are not formed, but simpler nitrogenous compounds that, however well they may please the palate, tend to scour out the intestines of animals.

we would have our plants at full feeding value, furnished with as much albuminoid foodstuff as possible, we require excess rather than defect of sugar. That is to say, the plants must have had a sufficiency of light, so as to provide sugar in such abundance as will secure the formation of the albuminoid foodstuff, and not immature, imperfectly formed compounds.

4. CELLULAR STRUCTURE. — We said at the beginning of this article that every plant must start from some part or other of a preceding plant. Now microscopic investigation shows that at first all plants are built up of cells, much in the same way as a honeycomb is built up of cells. Replace the waxen walls of the honeycomb by the tougher material called cellulose, fill the compartments with living substance or protoplasm, reduce the size of the chambers to microscopic dimensions, and you get a fair idea of the cellular structure of a simple plant. Or we may compare a plant to a house of many minute chambers, with walls built of cellulose and lined with living substance. Each chamber of this house is a cell.

At first the cell is quite small, but afterwards it drinks in water by the osmotic process and becomes puffed up to many times its original size. The water used in this way amounts to about 80 per cent of the total weight of the plant. When a mushroom grows up in a single night, what has happened is mainly this: the many small cells composing its body have been puffed up with water from the soil. Again, when a bud opens in spring, the enlargement is due to the fact that the many small component cells have increased enormously in size, simply by puffing themselves up with water that has streamed into them from the soil through the other parts of the plant. A time comes when the wall of the cell is too thick and stiff to be puffed up in this way; then, the full drinking capacity has been attained, and further enlargement ceases. To get a *heavy* crop of plants we thus require that the cells be enlarged as much as possible; and besides this, we require the presence of as many cells as possible to undergo enlargement.

In order to make the cells as large as possible, we need some agent that not only induces thirst in the cell, but also retards as much as possible the stiffening of the cell wall. Such an agent is nitrate. Crops vary greatly in the extent to which they can stand forcing by nitrate. Cabbages, for example, can stand very much; so can potatoes, and some of the new varieties of oats can use much more than the old varieties. Clovers and leguminous plants, on the other hand, are very shy of nitrate. It requires intimate knowledge of detail and nicety of judgment to balance up the proportion of nitrogenous to other manurial constituents that may be most profitably used in a given case. As a rule, special experiments are necessary for such determinations. If we apply excessive dressings of nitrate, one danger is that the cells may become so large and watery that they collapse and break down utterly, as is seen in the case of hollow potatoes, and sometimes in lodged corn. Another danger from excessive use of nitrate is that the plant is apt to become unhealthy, and ready to fall a prey to disease and disease-producing organisms.

We have already said that to secure a full and heavy crop we want as many cells as possible. Indeed, the prime object of all intensive cultivation is to increase to a maximum the number of those special cells which constitute the valuable part of the crop. The secret underlying the attainment of this end is the knowledge that there is, in each and every cell of a plant, a special globule, which lays down the law in this matter, and decides whether or not the cell shall 'divide' into two cells, and also whether the 'division' of the cell shall be repeated. This official within the cell is to be got at through his food. The object of the cultivator, then,

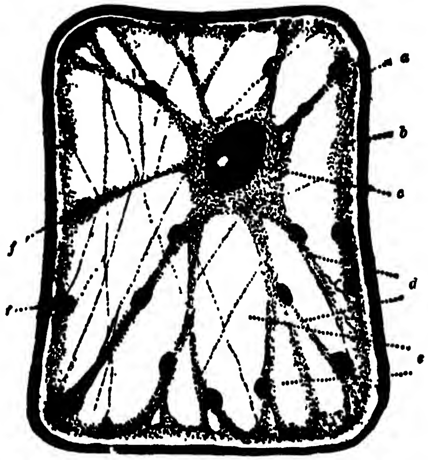


Fig. 2.—Diagram of Cell (greatly magnified)

a, Cell wall. *b*, Protoplasm round the wall. *c*, Nucleus (with nucleolus). *d*, Protoplasm in strings. *e*, Vacuoles containing cell-sap. *f*, Chlorophyll grains (green).

is to cater in the first place for the globule in the cell, which is technically called *nucleus*.

If we would use the nucleus to our end, and induce abnormal increase in cell numbers, we must act upon the nucleus through the environment of the plant. This can be done, for the nucleus requires a special foodstuff—not ordinary albuminoid, but a special albuminoid manufactured from phosphates. If phosphates are deficient in the soil the powers of the nucleus are crippled, and the number of cells forming the plant is defective likewise. We thus see that excess rather than deficiency of phosphate in the soil is advisable, if we would have our plants with excess rather than deficiency of cells to puff up and to feed.

Phosphates are used by the plant chiefly for manufacturing those special albuminoids which go to feed the nucleus of the cell. For this manufacture four substances are required, namely, sugar, nitrate, sulphate, and phosphate. The proper use of phosphates lies at the very heart of all profitable farming. There are ways by which soils poor in nitrogenous compounds may be enriched from atmospheric sources; but there is no such way of supplying phosphates. It is

then for the farmer to see specially to it that the phosphates are present in sufficient amount, and that as much as possible of the phosphates in the depths of his soil are brought to the surface and made available by the growth of deep-rooted plants. After the cell has commenced to enlarge, and has puffed itself up with water, the nucleus will not 'divide', and the cells will not increase in number. Accordingly, the phosphates are wanted in the very youngest cells, rather than in the older. The plant grower must not force the cells of his plants to enlarge too rapidly at first; if he does, he defeats his own object, and makes the nucleus abdicate its powers too soon—at least sooner than is necessary. For this reason, the quantity of nitrate applied and the time of application require judgment, if we would secure the best return.

5. Respiration.—Light is the special power which works the green machinery of the plant when it is manufacturing sugar. But another power is required prior to light, and a power without which light avails nothing. The source of this power is the breathing process, or respiration. Every plant and every animal gets its 'vital power' by breathing; without breathing, a green plant is as impotent to act as a man with a rope fastened so tight round his neck that no air can enter his lungs. The important point is, that the breathing process of the plant is exactly the same as the breathing process of the farmer himself. To maintain the life of each of them, breathing is absolutely essential. The substances involved in this process are two, namely, the living substance (not the food), and the oxygen of the air. Now the plant gets its air supply from two sources—from the atmosphere, which bathes the air parts, and from the soil atmosphere, which bathes the underground parts. If, then, our plants are to be at full vigour, there must be no stint of air supply. Nevertheless, the air supply of the plant is very often specially stinted—not, of course, the supply to the air parts, but the supply to the roots underground. This happens whenever the pores of the soil are filled up with water. It is all very well if these water plugs in the pores are charged with oxygen. But if the water is stagnant, and has risen from the soil beneath, then occurs the danger of stinting the air supply. To minimize any such risk, two methods are in use: (1) drainage, and (2) the incorporation in the soil of dead parts of plants or dung,—in fact, organic matter of any kind. The organic matter has the special property of swelling in water, as we easily notice in the case of a boat leaking at the seams or of a shrunken tub. The action of the organic matter in the soil is to absorb into itself the water from the pores, and leave them free and open. When it happens that the air supply at the root is scant, the effect on the root is remarkable. The breathing becomes abnormal, alcoholic poison is produced in the interior, and the result is a diseased root, defective in the discharge of its duties.

6. Propagation and Reproduction.—*Propagation.*—The farmer is inclined to call everything from which a plant takes its rise by the name 'seed'. When he grows his potato crop from tubers, he speaks of the crop as grown from seed, and the tubers from which he grows the crop as 'seed' and 'seed potatoes'. This is often a very handy way of speaking, but at times it may lead to error, as, for example, when we are discussing the peculiarities presented by new varieties of potatoes raised from 'seed'. In this case of new varieties, the potatoes are not raised from tubers but from genuine seeds produced in the 'plum' or fruit of the potato plant. Again, weeds often start from pieces of the plant which are in the soil. For example, a tiny piece of the underground stem of couch grass is the usual starting-point of couch; a piece of agrostis or bent grass the starting-point of bent; a piece of knot grass the starting-point of knot grass, and so on. Cases of this kind, in which the plant starts from a part of the *vegetative organs*, are so numerous and so important that, to prevent confusion, it is well to speak of them as cases of propagation rather than of reproduction.

Reproduction.—When a potato plant is raised from the seed that was formed in the 'plum' fruit, we have a genuine case of reproduction. In this case, the plant has not been produced from a part of the vegetative organs but from a special structure specially formed by flowers or reproductive organs. In point of fact, the starting-point was a baby plant or embryo formed within a seed. It is worth while understanding how this baby plant comes to be in the seed. Assuredly it is not taken into the plant from the soil, as was formerly supposed, but, like the animal baby, the plant baby is always made by the blending of two things, a male element and a female element; the male element by itself is impotent to produce an embryo, the female element by itself is equally impotent, but both elements blended together are effective. This is the great and essential difference between propagation and reproduction. In propagation a part of the plant is detached, in reproduction two distinct parts, namely the male element and the female element, are blended together to produce one. Such blending is called a sexual process.

This being so, it is easy to understand how plants raised from embryos may sport and change, and give rise to new varieties. The male element carries with it *certain* characters from the plant which bore it, and so likewise does the female element. The blended product of both elements evidently combines in one embryo plant both sets of characters. It is clear also that if we select the male element from a plant with suitable characters, and the female element from another plant with other suitable characters, and if we further bring it about that both elements successfully blend, we get an embryo combining together in it the characters carried in by both elements, that is, a new variety. What characters are carried in, what characters come to the front and show up as 'dominant characters', what characters remain hidden and 'dormant or recessive' depends upon the circumstances of the case. Reproduction by the sexual process thus puts into our hands a method of controlling the productions of

nature. By such control, new varieties of peas are easily produced, new varieties of potatoes, new varieties of oats, and so forth. The embryo of a flowering plant is very carefully tended and looked after by the plant itself. It is always produced inside a tiny case specially constructed for the purpose and called the ovule. If you take the very young pod of a bean and open it, you find in the inside a whole row of little white bodies; each of these is an ovule specially constructed to cradle and to nurse the embryo to be produced within. At first there is no embryo at all in the ovule, but there is a female element or egg. If, however, a male element gains access to this female element, both elements become blended together, and now the whole ovule swells up, an embryo forms in the interior, a store of food for nursing this embryo accumulates within, and the outside of the ovule becomes a protecting skin. At this stage, when an embryo has been developed, the name 'ovule' is changed to *seed*. Seed, then, is the ripe ovule which has been fertilized and which has developed an embryo in its interior. Without fertilization, seed is not produced.

The seed germinates when it is provided with adequate supplies of water, air, and heat. The embryo nursed on food stored for the purpose emerges and becomes a seedling plant. The seedling develops its vegetative organs and becomes the adult plant, which feeds on the starch, fat, and albumin manufactured by its own activity from the raw materials derived from soil and air. Flowers are developed, which contain, as essential parts, stamens and carpels. The stamens make pollen, and the pollen in turn makes male elements. The carpels make ovules, and inside of each a female element or egg is produced. The fertilizing process brings about the blending of male and female elements, and ultimately an embryo plant is developed within the ripe ovule or seed. The seed is shed, germination occurs, and the same cycle of life is repeated. [A. N. M'A]

Plasmodiophora brassicæ, the botanical name for the disease better known as finger-and-toe. See art. FINGER-AND-TOE.

Plaster of Paris. See GYPSUM.

Asparagus Fly (*Platyparæa pœciloptera*)

Platyparæa pœciloptera (the Asparagus Fly).—The insect is about the size of the house fly, with red-brown head, grey thorax with three longitudinal dark stripes, and dark-brown abdomen. The wings are prettily marked with five irregular, dark-brown transverse bars. The fly lays its eggs in April or May on the succulent shoots. They hatch in a fortnight or three weeks, and the yellowish-white maggots eat into the stem, distorting the shoot and generally causing it to bend over. In July or August they cease feeding and turn to pupæ in the lowest portion of the stem. *Treatment.*—Pull up and destroy the injured shoots in August, taking care to remove the lowest part of the stem with the pupæ in it. Dusting the shoots with soot as they appear has some effect in keeping off the fly. [C. W.]

Plectroscelis concinna (the Hop Flea-beetle) is allied to the Turnip Fly, but is broader and more convex, of a coppery hue, with pitch-coloured antennæ, rusty at the base, and twenty lines of strong dots on the wing cases. Early in the spring the beetle appears on the tender hop shoots, which it greatly injures. Later it attacks the leaves. The eggs are laid under the leaves, and hatch in six to nine days, when the larvæ tunnel in the leaves. They are mature in eight days, and emerge to pupate in the ground. In about a fortnight they turn to beetles. There are three broods in the year, and the winter is passed in the adult form, in broken pieces of bine or in rubbish under the hedgerows, &c. *Treatment.* — They are best combated by keeping chickens and ducks in the hop gardens, and by shaking down the beetles on to tarred boards. [J. C.] [C. W.]

Pleistocene, meaning 'most recent', has been applied to deposits later than the Pliocene period. The term *Post-pliocene* is held by many authors to include an earlier *Pleistocene* series and a later *Recent* series; but the limits of these are difficult to define. The pre-glacial beds with mammalian bones in certain caves, the pre-glacial beach-layers or eroded platforms of the South Welsh and Irish coasts, and the whole series of deposits of the Post-pliocene ice-age, may be taken as typical records of the Pleistocene period. See art. GLACIAL EPOCH. [G. A. J. C.]

Pleurisy.—Inflammation of the pleura or covering of the lung is a painful disease, and in the lower animals, especially the horse, it frequently terminates fatally. Until recently, the chief cause of the malady was believed to be cold or chills, but now it is held that bacteria play an important part in its production. Quite a number of bacteria are capable of causing pleurisy, but the pyogenic or suppurative organisms are undoubtedly the most frequent offenders. In cattle the *Bacillus tuberculosis* is the most common cause, and gives rise to a special form of pleurisy termed tubercular pleurisy, which may be either acute or chronic, the latter being the more common. In horses the *Bacillus mallei* or glanders bacillus may be a cause, but this is rare as compared to pleurisy determined by suppurative organisms, which gain access to the pleura from some centre of disease in the underlying lung tissue.

In the early stages of pleurisy the chief symptoms are quick, hurried, shallow breathing; short, painful, suppressed cough; anxious expression; the affected animal looks round frequently at its sides and moves in a stiff, pained manner. The temperature is elevated, and as a rule the patient is disinclined to lie down. If we apply our ear to the chest wall we can distinctly hear a delicate rasping sound, which is not present normally

This is caused by the dry inflamed surface of the lung rubbing against the chest wall or inner surface of the ribs, and gives rise to great pain and uneasiness. As the disease advances, the friction sounds disappear gradually and may be replaced by a splashing sound, due to liquid accumulating in the chest cavity. The severity of the disease depends upon the extent of the pleura involved, and if one or both sides of the chest are affected. Provided the lesion is limited, then recovery may take place; and the only evidence remaining to prove that the disease has been in existence will be the presence of a thickened patch of pleura. On the other hand, when the disease extends and gradually involves the entire surface of one or both lungs, we generally get a profuse outflow of inflammatory liquid into the chest cavity. This exerts pressure on the lungs, interferes with respiration, and frequently entails a fatal issue.

In the case of tubercular pleurisy in cattle the disease usually runs a chronic course, and after some time peculiar outgrowths resembling bunches of grapes appear on the inflamed membranes, and also on the pleura covering the inside of the ribs. These masses are composed of a framework of fibrous tissue developed from the pleura, and embedded in this we find cheesy-like tubercular material, produced by the activity of the tubercular bacilli, which are usually present in enormous numbers. The term 'angleberries' has been applied to these grape-like masses, but is misleading, as they have no connection whatever with true angleberries, which are of a warty nature and grow on the skin of cattle, particularly about the floor of the abdomen, and apart from being unsightly are not of much pathological importance. [J. R. M'C.]

Pleuropneumonia.—This contagious disease, which during certain years of the last century caused great loss among the herds of Great Britain and Ireland, has fortunately now entirely disappeared from these islands in consequence of the strong measures of suppression adopted by the authorities. It is supposed to have been imported from Holland about the year 1841, having been known previously in various Continental countries. From time to time it has appeared in nearly all parts of the world, though it is said that Hungary, Normandy, and Algeria have so far been exempt from its ravages. It is a highly infectious disease and is generally fatal, being contracted by inhalation. As the name pleuropneumonia indicates, the seat of the disease is the lung, with its covering membrane (the pleura). The attack may be acute, subacute, or chronic, and in consequence it is not possible to fix a very definite period of incubation, the latter being variously estimated at from two weeks to several months. It is not uncommon for animals to be affected for a long time unsuspected, and as a result the disease is insidious in its spread, the contagion being conveyed by animals which have not themselves exhibited any clinical symptoms. Where the course is chronic, animals sometimes appear to recover; but from the nature of the lesions perfect restoration of the lung tissues is rarely possible, such cases, commonly known as 'lungers', being a fruitful source of contagion.

The symptoms of the disease are those of fever, with a cough, at first slight, afterwards more severe, the elevation of temperature being usually marked, and occurring early in the course of the attack. The usual signs of illness soon appear, including loss of appetite, cessation of rumination. The cough becomes more painful, the animal arching its back and extending its head, and showing pain on pressure between the ribs. The breathing becomes laboured, with marked 'heaving' of the sides, and as in the case of other fevers there is here usually constipation, while from the distended nostrils there is a discharge of a tenacious character. At first the sounds in the chest appear exaggerated when the ear is applied to the chest wall, but after a while there is loss of sound, the air passages being more or less closed and the lung cavities obliterated. The friction sound which is diagnostic of pleurisy is at first marked, but after a time ceases owing to the throwing out of an exudate between the lungs and the lining of the chest. The discharge from the nostrils changes, becoming yellow and often containing 'casts' of semi-solid matter from the air passages. Death usually occurs in from one to three weeks, and is generally due practically to suffocation owing to inability to inspire air into the lungs. Postmortem examination shows a remarkable alteration in the lungs, which have become very heavy, and on being cut with a knife the cut surface shows an appearance which is generally likened to marble, there being thick yellow streaks running in various directions and enclosing spaces full of dark material. In the chest cavity there is usually a quantity of fluid. Owing to their increased weight the lungs will not float when placed in water, as would be the case if the lungs were healthy.

Treatment of pleuropneumonia is not permitted in these islands, this disease being among those scheduled as notifiable.

Enormous sums were spent in eradicating it, the procedure adopted, which ultimately proved successful, being the compulsory slaughter not only of affected animals, but also of those which had come in contact with the latter.

Restrictions are still in force against the importation of living cattle from certain countries, with a view to prevent the reintroduction of this and other diseases. In some countries inoculation with lymph obtained from affected animals is practised as a preventive. [F. C. M.]

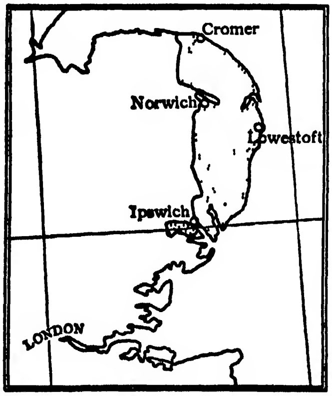
Pliocene System.—This system is usually regarded as closing the Cainozoic or Tertiary era, and possesses considerable interest through the similarity of its marine invertebrate remains to those accumulating at the present day. At the same time, a number of important Pliocene vertebrates have become extinct. Among these is Hipparion, the old three-toed horse, which is succeeded by the true horse in the Upper Pliocene. The modern ox occurs also in the later Pliocene deposits. The length of the interval that separates us from Pliocene times is seen by the fact that marine beds of the upper series of this system in southern Italy have become elevated nearly 3000 ft. above the sea.

In Belgium and eastern England we have

deposits formed in a sea that represented the present German Ocean. These give us the loose fossiliferous sands known as 'Crag' in Suffolk and in Norfolk. The English Pliocene strata are largely overlain and concealed by glacial drift; but small quarries have been opened in them, and they are well seen along the coast. Their succession is as follows:—

4. Forest-Bed Series.
3. Norwich and Chillesford Crags.
2. Red Crag.
1. Coralline Crag.

None of the series is of great thickness, and the sea seems to have retreated for a time, owing to an uplift at the close of the Coralline Crag epoch. Numerous fossils washed from the lower series are thus found in the Red Crag. The Red Crag, on the other hand, extends beyond the Coralline Crag, overlapping it on to the London Clay.



Sketch-map showing Area of Pliocene Strata in Eastern England. Pliocene area dotted

The *Coralline Crag* is a very shelly yellow sand, some 60 ft. thick, with numerous remains of polyzoa, once styled 'corallines'. A formerly valuable bed of phosphatic nodules, with sharks' teeth, &c., occurs at the base, and numerous nodules have been washed from it into various layers of the Red Crag. The bed is now practically worked out, but may appear between the Crag and the London Clay at points not yet explored. The *Red Crag* is usually dark-coloured through iron oxide, which cements it, after the fashion of iron-pans, in places. Here and there, dissolving waters have removed most of the calcareous matter from the sand.

The *Norwich* and *Chillesford Crags* represent higher horizons. They include thin clays, which amount to some 8 ft. in the Chillesford series.

The *Forest Bed Series* appears at Cromer in Norfolk, and its fauna indicates the gradual change of climate towards the cold of the Glacial epoch. The Forest Bed proper is estuarine, with stumps of trees washed down from the river-banks, and bones of Rhinoceros, Hippopotamus, Elephant, Bear, the extinct Sabre-toothed Tiger, &c. It is in part cemented by iron oxide.

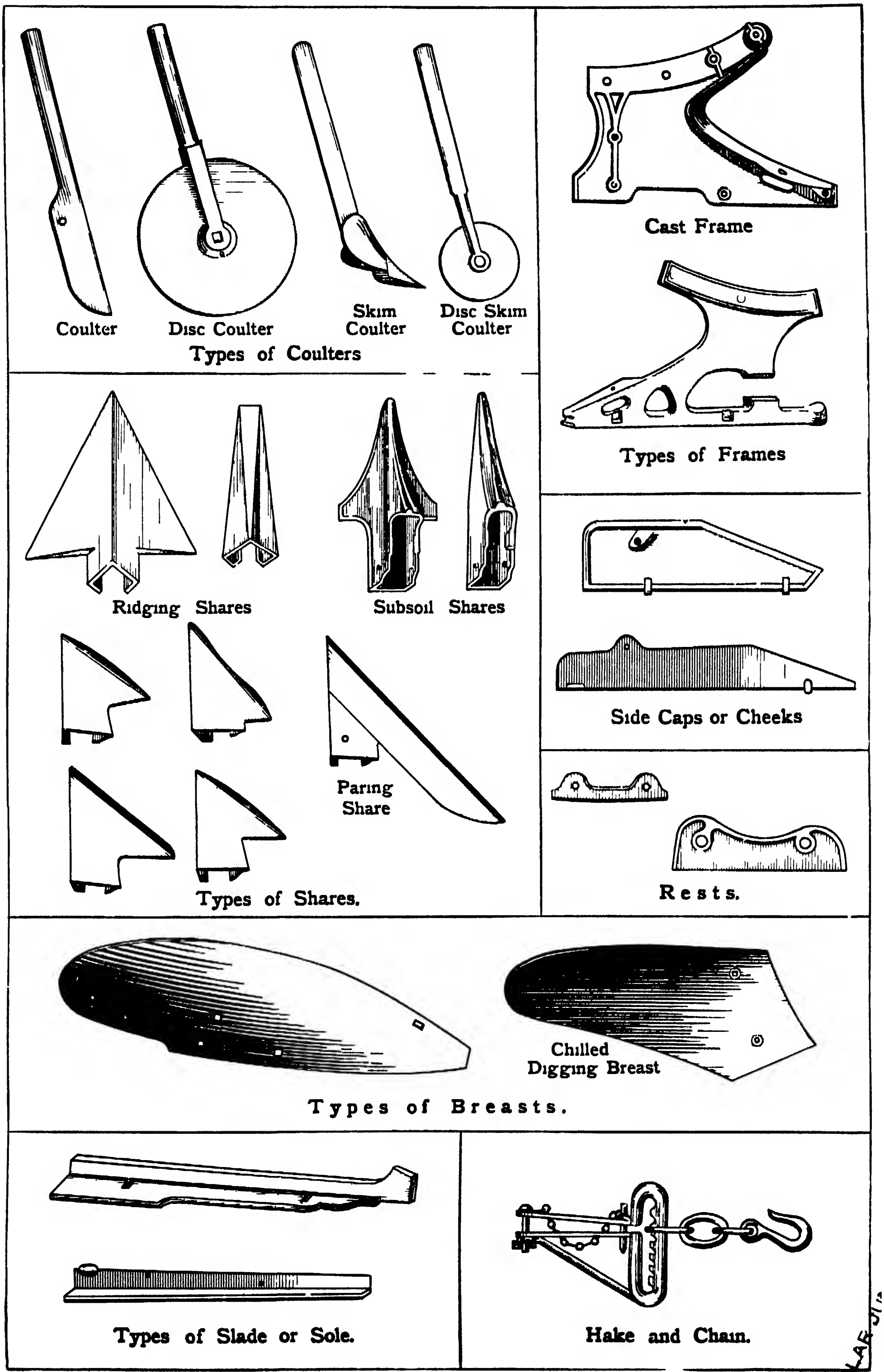
The former extent to which the Pliocene sea invaded south-east England is shown by the occurrence of the *Lenham Beds*, which are fossiliferous sands preserved in solution-pockets in the Chalk of the North Downs of Kent. These relics of former strata show, moreover, how recent, geologically speaking, is the formation and excavation of the 'Wealden anticlinal', that great denuded arch of Cretaceous strata which divides the London from the Hampshire Basin.

An inlet of a more southern sea is recorded by a small pocket of fossiliferous sand and clay at St. Erth, not far from St. Ives in Cornwall. But on the whole the Britannic area was raised above the sea in Pliocene times, and the estuary of the Rhine, at the close of the period, probably spread to the East Anglian region, forming a broad connection with the Continent, by which mammals passed freely into England. A less shifting connection was also provided by the Wealden anticlinal, which then stretched continuously into northern France. [G. A. J. C.]

Pliocene Soils.—The soils which rest on the Pliocene strata or 'Crag' formations of Norfolk and Suffolk are very variable in character, chiefly because of the occurrence of so many kinds of drifted materials on the surface. These drifts are mostly clays with chalk fragments, or Glacial sands and gravels. The clay with chalk pebbles is really a boulder clay derived from the Chalk formation, and is widely distributed over the 'Crag' in the county of Suffolk, and over a more limited area of that formation in Norfolk, while the sands and gravels prevail in the district round Ipswich and at various other points of the series. On these superficial deposits soils of varying degrees of fertility are to be found, from the rich loams lying at the margin of the formation to the south and south-east of Ipswich, and again in the north-east of Norfolk, to the poor and heath-covered sands which present themselves here and there towards the eastern side of these counties near the coast. The country to the north-east of Norwich, comprising the hundreds of Blofield, Walsham, Tunstead, Happing, and East and West Flegg, is considered the best land in Norfolk. Its soil is a deep free-working loam, very suitable for arable culture. It is, however, deficient in lime.

Directly derived 'Crag' soils are the exception rather than the rule. Where they exist, they prove to be calcareous sands or loams; the soils from the Coralline 'Crag' possess a higher content of lime than those derived from the newer strata. Some of the soils are so sandy and incoherent that they drift with the wind after ploughing, and in hot dry seasons the crops they produce are light and almost scorched. In the river valleys round Norwich the Crag forms a loamy soil on which the beech tree flourishes. Some of the beds of this system, such as the Norwich Crag, are so calcareous that they are used as a soil-amendment. The phosphatic beds have been worked for the manufacture of manures, and the nodules were formerly sold for about £3 per ton. The 'box-stones', which prevail mostly in the south of Suffolk, are used for road metal. [T. H.]

Plough.—Ploughs are made to meet special purposes and conditions, and show variations



PARTS OF THE PLOUGH

to adapt them to the work, but practically all come under one common constructive plan—that the forepart is a stout beam which makes a fish-hook curve at the rear, the point of which pierces and forces its way through the ground; and a side sheet of metal called the mould-board or breast, which shoves the loosened soil aside and inverts it. These are the essential parts, but other parts and adjustments are attached to make it easier to control, and to adapt it to special purposes. The beam is usually continued behind the curve so as to form a steering or guiding handle, and wheels are frequently attached to the forepart to make the running steady and to regulate the size and depth of the furrow; but wheels are not essential, as they are not used on the swing plough. A description of the parts of the common, single-furrow, two-wheel plough will render their purpose clear, and the object of parts substituted in other ploughs will then be obvious. Having the parts of a plough before us, we will proceed to put them together. The frame or body to which all the ploughing parts, except the coulter, are attached is bolted on to the beam, as also are the handles or stilts; the wheels are then put on so that the plough can stand upright; the standards of the wheels are carried in sockets fitted to the crossbars placed in the forepart of the beam, to which they are clasped. The slade or sole of the plough should then be placed under the frame, then the lever neck to carry the share be laid in; then the frame and breast couplings be attached to the frame, after which the breast should be attached, and held in place by a bolt near the front, by the frame coupling, and by the breast stay, the latter keeping the back part of the breast rigid, though it is adjustable from the breast stay and breast coupling. The side cap can then be put on, and the share slipped on to the lever neck. At the bottom of the breast is the rest, a renewable part to save the more expensive breast from wear. At the end of the beam is a T-head somewhat quadrant shape, perforated with numerous holes, which fits into the sliding head carrying the adjustable stay of the draught chain. A hake head is substituted for this when, instead of taking the draught from a draught chain attached near the body, the chain is dispensed with, and draught taken direct from the head. With the coulter placed in front of the share point, and the skim coulter slightly in advance of this, the plough is complete, though a draught chain attached to the coulter is often used to drag in manure or long growth.

The purpose of the parts are these. The share makes the under cut and the coulter the vertical. The cut furrow-slice runs up the share and follows the course of the breast as it is drawn along; the curve of the breast is such that the furrow-slice is inverted as it leaves it. The depth and width of the furrow are adjusted mainly by the wheels. The big or furrow wheel adjusts the width of the furrow, the width taken being that which lies in a line between the coulter and the inside of the great wheel, which also regulates the depth of the furrow on the turning side; the little wheel only regulates the depth on the land side. The sliding head can be moved from side to side along the T-head to adjust the line of draught to aid the holder to steer the plough; and the sliding head also can be raised or lowered to correct the tendency for the point to run unduly upwards or downwards; in both cases the adjusting is done in opposite direction to the one desired. The skim coulter is only used when there is manure or other material on the surface which requires burying. A disk coulter is used on loose land free from stones, where there is likelihood of the ordinary coulter driving the loose material in front, and so blocking the plough.

The *common plough* just described is typical of the ploughs most generally used. After its introduction in its present form about the middle of last century there was great controversy as to the merits of the wheeled plough *v.* the swing plough. The disuse of the swing plough except in certain districts is the most conclusive evidence of the popularity of the wheel plough. We think the advocates of the swing plough adhered rather to the work performed by the swing plough than to the fact that it was wheelless. On this ground we have some sympathy for their adherence, for despite the almost common use of the wheel plough, the long snake breast entailed very heavy draught, while the breast associated with the Scotch swing plough was rather more on the lines of the modern digging breast plough, which is much lighter in draught than the common plough; and the Scotch users preferred the type of furrow-slice turned by their breast. There is no doubt about the convenience of wheels, and we think it was unfortunate that the controversy turned so much on the question of wheels rather than on the class of work performed. The common plough with its snake breast is eminently a wheat plough, as it leaves a firm consolidated furrow well suited to the wheat seedbed, and a well-defined crest suitable to receive seed when sown broadcast; but to attain this the draught is excessive; and as wheat sowing has decreased to less than half its acreage during the past thirty or thirty-five years, the value of this consolidated furrow is not so much appreciated. The common plough is, however, popular because it will face a hard surface when some other types are unable to do so. It performs the neatest work, and its popularity at ploughing matches had much to do with its adoption. Its excessive draught is due to the great friction which is set up at several points, especially on the slade or sole-plate, the land side or side cap, and on the breast. A long, broad slade is necessary to keep the plough steady, and how great the pressure is is shown by the compressed and polished track it leaves. The turning of the furrow under compression puts pressure on the side cap and breast, because the furrow-slice is but slightly lifted, and is turned directly over whilst in the narrow space between the unploughed land and the previous furrow. The effect is similar to that where a wedge is driven into a space with resistance on both sides. Repeated tests have shown that in ploughing firm land the draught of the more modern chill breast digging plough

is about one-third less than that of the ordinary plough; and as the bottom and vertical cuts have to be done in common by both ploughs, the difference must be attributed to friction.

The *swing plough* if fitted with an ordinary breast has most of the frictional troubles of the common wheel plough, but a skilled ploughman can maintain a firm and well-controlled grip, which tends to make it run slightly easier, though an unskilled holder will increase the draught. The fact that a swing plough is designed with longer handles and a shorter beam allows it to be held more easily than a wheeled plough freed of its wheels does.

Digging ploughs with chilled-steel breasts were introduced to England about the year 1885 by Oliver, and they have proved to be the most economical ploughs to use under most conditions. Objections to their use on strong land have in the main disappeared, as farmers have realized that the high crest, which they regarded as essential when using ploughs which consolidated the furrow, is of relatively small importance with the open-work furrow of the digging breast, which admits air and frost readily to all parts. Whereas the breast of the common plough squeezes the furrow-slice over in a narrow space and involves great friction, the digging breast, from its shape and setting, as it were 'shovels' over the furrow-slice where there is little resistance; the soil runs up the shovel-like blade and is flicked over by the wing of the breast, forming a broken-backed furrow-slice, which falls lightly and well broken to be weathered. The parts of a digging plough are far fewer than those of the common plough. Owing to the down pressure being so little, the slade, as compared with the common plough slade, is very small, while the pressure on the side cap and breast wing are also very small. The front or shin of the breast acts as a coulter; it is not set quite vertically, but reclines slightly towards the unploughed side. The skim coulter can be used to cut a coulter track if desired. Most English makers mount the breasts on heavier beams than is necessary, as they find that English farmers will not buy ploughs that do not closely resemble the form to which they have long been accustomed. Some excellent plough parts devised by English makers became obsolete because they did not conform to purchasers' views.

The *Kentish or Sussex plough* is in reality the Anglo-Saxon plough with little alteration, as shown by the specimen of the latter at Lewes Museum. It turns a broken-back furrow very similar to that of the digging breast. No plough yet does better work on the Weald than these old wooden ploughs, especially when the surface is hard; they will face a surface that no other plough can enter. Their deadweight is great, but through the small friction everywhere except on the slade, which does not exceed that of the common plough, the draught is not excessive as compared with the common plough. They are turn-wrest ploughs, the mould-board being shifted from side to side at the end of the furrow, and the coulter is brought over by shifting a stake held between two stays. Some forms are made with gallows heads for hill work, and some have ordinary wheels. The share is chisel-pointed about 6 in. wide, with a long thick sleeve.

The *gallows plough* is used for hillside work. Instead of the wheels being secured rigidly to the beam, they are carried on a fore carriage, the beam riding between them. This enables the holder to balance his plough independently of the position of the wheels.

Turn-wrest ploughs take many forms, and are constructed so as to allow the furrows to be laid in one direction, so that there is only one ridge to set and no open furrows or finishes. Where land does not require open furrows to carry off water they are decidedly good; and in their modern forms they add but little to the draught.

Subsoil ploughs are ploughs fitted with a body forming a mole, and are used to break up the hard pan which often forms at the bottom of furrows; for this reason they follow the track of an ordinary plough, breaking up, but not necessarily inverting the subsoil.

Steam Plough. See art. STEAM PLOUGH.

Gripping ploughs are generally contrived by fitting a suitably made body to the beam of an ordinary plough; makers supplying these. The sides of the turf are cut by two vertical shares, and a specially shaped breast throws the turf furrow out. They should be much more commonly used.

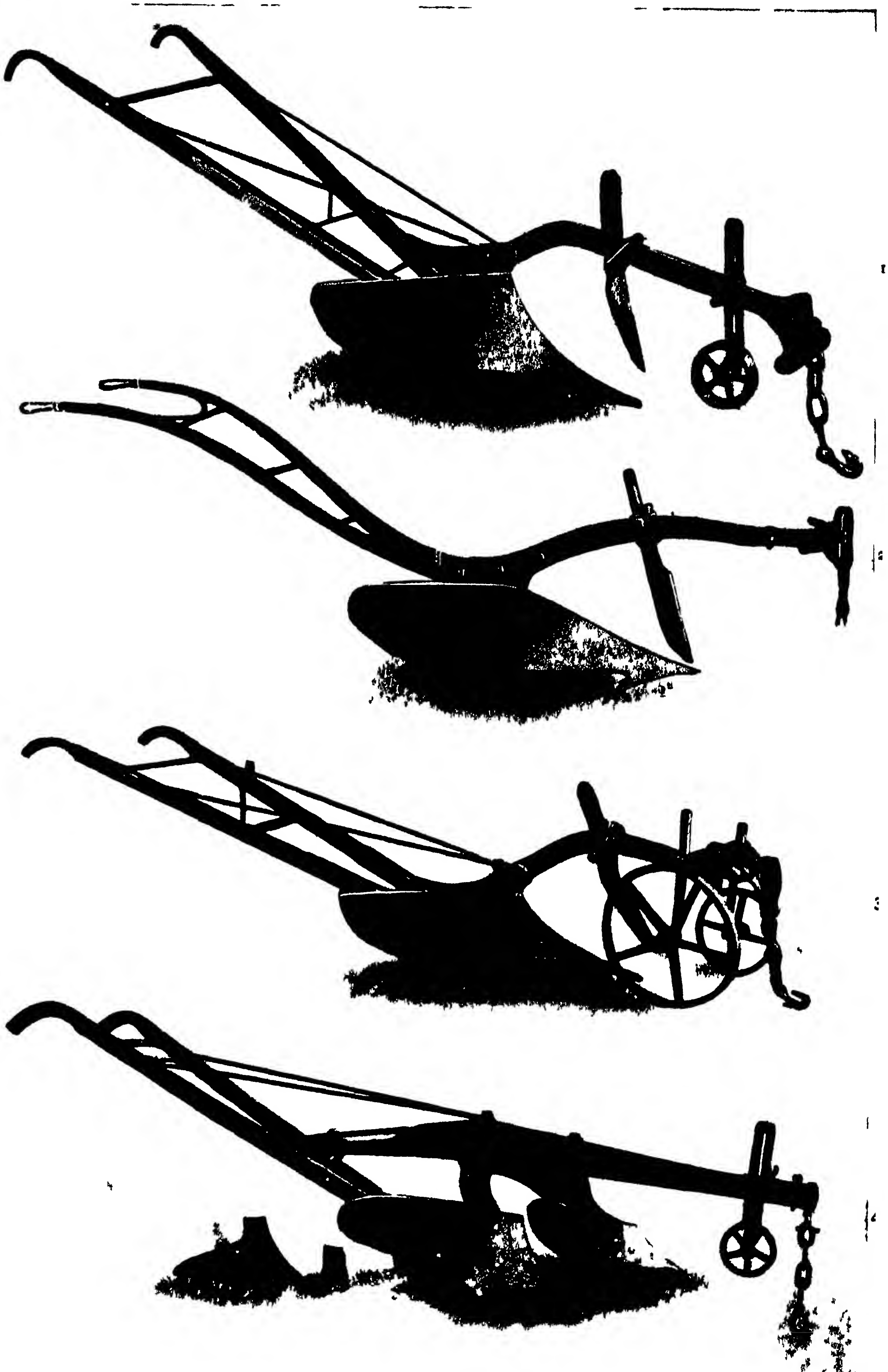
Turf-paring ploughs are made somewhat similarly to gripping ploughs, but the turf is allowed to rise over a raised back, and fall behind the track of the plough.

Potato plough, an implement less commonly used than formerly. See POTATO PLOUGH.

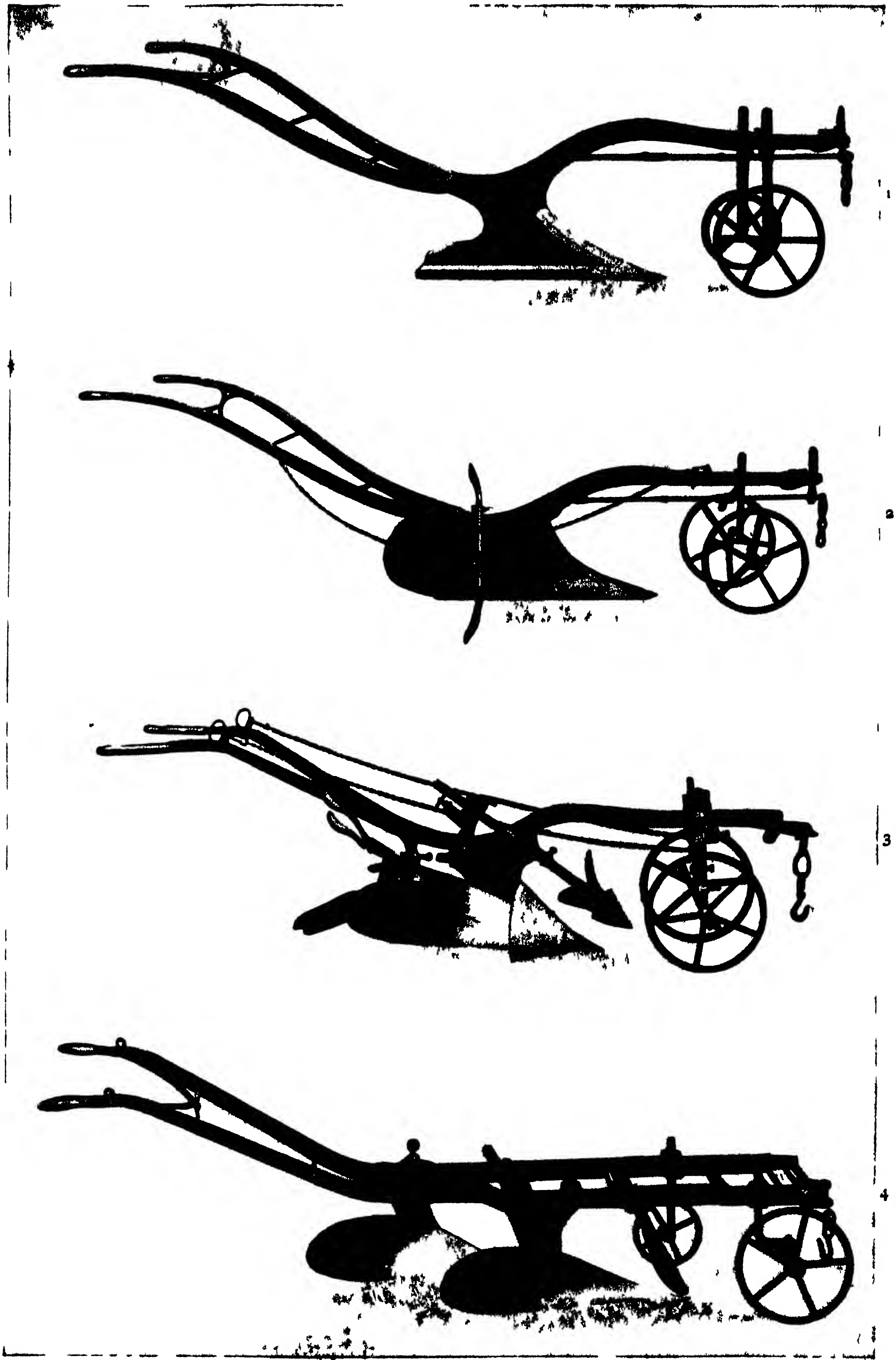
Disk ploughs are made with disks in the place of the ordinary share, coulter, body, and breast. Set at an angle somewhat across the line of draught, as the plough advances the saucer-shaped disks revolve, the fore edge cutting a way, and in revolving turning the cut turf aside. It is more suitable for land in which there is much fibrous growth, as in breaking up pastures, and as such is used freely in breaking up prairie. It will, however, work well on soils free from stones; and as it masticates the soil, producing a seedbed direct, is a very valuable implement. In the British climate, where it is generally preferred to allow the soil to weather before cropping it, these ploughs attain little popularity, but are deserving of more common adoption.

Gang Double-furrow and multiple ploughs have attained much popularity in the Colonies and new countries, but little at home. Of the economy of working more than one furrow there can be no doubt; but the ploughs offered to the British farmer are as a rule unsatisfactory, because, through the small frames and consequent close placing of the bodies, there is not sufficient room for the manure, stubble, or loose material to pass through, and they block. In the Colonies the more casual farming and more general use of disk ploughs cause less objection; moreover, Colonial farmers are better catered for. For ploughing our hard soils, also, the rigid bodies

PLOUGH—II



1, "Oliver King" Lea Plough. 2, Howard's Swing Plough 3, Senior Dux Plough (Jack, Maybole).



1

2

3

4

1 Howard's Subsoil Plough 2 [illegible]'s Ridging Plough 3 Turn-Wrest Plough (Ransome's).

are not well suited, as there is a tendency for one point to ride the other out, and they should be made with some slight yield to meet this difficulty. For ploughing land already stirred, and where there is no manure to plough in, there are many double and multiple ploughs well fitted to work, and which would prove infinitely more economical than single-furrow ploughs.

In respect to the merits and value of a plough, the Royal Agricultural Society of England drew up the following points to control their awards in their most recent competition:—

Price	10
Mechanical properties	20
Simplicity	10
Draught relatively to work done	20
Flatness of sole of furrow	10
Perfection of work of burying vegetation	25
Efficiency of skim coulter	5
	100

[W. J. M.]

Ploughing.—Ploughing calls for a considerable amount of skill and experience on the part of the ploughman, for it is not merely necessary to plough a straight furrow, but to be able to adjust the plough to the very varied work it is called upon to perform. On flat land in fairly good condition a plough should be set so that it will hold up to the furrow-slice from end to end of the field without guidance; failing this, unless there is great variability in the condition and nature of the land, the plough is not well set. If this test be applied to ploughs as they are found at work, only a small proportion will show satisfactory setting. A plough allowed to run like this will probably not lay its furrow well, because the little wheel may cut in too deeply or may ride off the land in places; and it is the duty of the ploughman to keep a good grip on the plough to maintain a proper balance. It would be advantageous if all ploughmen were taught to hold a swing plough, for then they learn the necessity to keep the plough balanced and acquire the knack of doing it. Wheels greatly facilitate the holding, but they are apt to make careless ploughmen, who when the plough does not hold up to its work are liable to correct it by pressure, and they are able to do this indiscriminately when the plough is partly balanced on its wheels. Every ploughman should be shown by means of a dynamometer how enormously he increases the load on the horses even by slight pressure. Yet it is a very common experience to see a man walking with one or even two feet out of the furrow, bearing the greater part of his weight on the handles all day, and although he may have been a ploughman all his working life, he is still unable to set his plough properly.

The art of holding the plough is mainly a matter of balancing, the parts of the body and breast of the plough in contact with the ground being the pivot; but the pivot is not placed at any fixed point, it being necessary to find by experience the best point to employ accordingly as resistance is met, or a specific object is desired. Briefly, pressure on the handles raises out the point; lifting them in conjunction with the draught of the horses when the draught chain is placed high in the hake tends to make the point dip; but the lift requires a firm grip and possibly a backward drag. Shoving the handles from the left brings the head of the plough towards the left, and from the right to the right, as in any ordinary pivoting. Friction is relieved when the holder, wishing to press on one handle to produce an effect, lifts correspondingly with his other hand, maintaining a firm grip which carries the plough; but this is done only by those who evince an interest in their work and have a care for their horses. In turning a plough at the ends it should always be thrown on the big wheel side, and slid round on the heel of the slade and the breast rest, whether turning to left or right, as then the headland is not cut up; in some dry-land districts the plough is run round on both wheels, making an untidy headland, which if persisted in on heavy land in wet weather, would cause it to be so churned by the treading of the horses as to be practically impassable. The purpose of the parts has been described (see art. PLOUGH). The wheels mainly adjust the depth of the work, but the furrow wheel also regulates its width; the width of the furrow being that lying between the inner side of the big wheel and the line taken by the coulter. Ploughs set to pull into their work, that is, where the furrow wheel bites the land hard, cut ½ in. or more on soft land than where they run easily up to it; and it is accentuated when through the wearing of the axle the wheels do not run vertically true. The tendency to run too hard on the land, or too much away, is corrected by altering the position of the sliding head; in view of the pivoting the head is pushed in the opposite direction to that which the plough is desired to take. The tendency to run into the ground is corrected by altering the draught chain to a lower point in the head; and to make it point downwards the draught chain is raised. On changing a share which has worn short for one which is new and long-pointed, it is necessary in exact ploughing to readjust the plough, as owing to the downward pitch of the share point it may, according to the state of the land, plough ½ in. or more deeper than the old one. The setting of the coulter, whether set wide at the cutting edge—that is, towards the unploughed land—or narrow, greatly influences the run of the plough, as it has a great tendency to follow the setting, and it is better to set this to ease the draught than to have to apply great pressure to keep the plough running true. All parts of the plough should be kept in good order, with all parts plumb and true. All adjusting parts should have their nuts and bolts kept well greased to facilitate alterations and to prevent the threads being cut by too hard screwing.

The first essential in ploughing is that the ploughman shall be a good horseman, and this the boy should learn while driving horses drawing implements which require no steering. He should be able to drive with lines a team of two, three, or four horses abreast, so that he will not need the help of an assistant though he works a single or multiple plough. Horses readily learn to obey the voice and to understand the

terms employed to direct them, and a good horseman will soon get a team to answer instructions with the very rare use of the lines. A man who depends on the lines is rarely a first-class ploughman. He requires his horses to need little other guidance but the voice when opening up fresh lands or ridges where there is not a furrow to guide the horses. He should also understand what class of ploughing is required for the different crops he is preparing for, and in accordance with the season.

With all but turn-wrest or one-way ploughs it is customary to plough the ground in lands or parallel widths convenient for turning; though on heavy land, high-backed lands giving narrow ridge and furrow are commonly made with the view of forming channels to carry off the surface water; and it is below the furrows that the under drains are usually placed. Generally these lands are straight, but in the south-east Midlands they very often take a serpentine form known as S-lands. The lands vary considerably in width. On light soils 22 yd. is most common; on heavier soils they vary according to the fall of the land and its consistency, as well as to local practice, from 9 yd. to 3 yd.; the latter are adopted in some districts so as to take the width of a drill, and the horses do not walk on the part to be drilled, but in the open furrows at the side. In some districts foul land is raftered; that is, the plough ploughs a furrow and misses a furrow, a turned furrow thus lying on an unturned furrow. See also RAFTERING.

Before explaining the method of setting out lands it is well to consider the forms of furrows. The furrow-slice is the slice of land cut below by the share and on the side by the coulter, inverted by the breast; the space between the unploughed land and the ploughed is the horse walk or furrow proper. Ordinary breasts are not set to completely invert a furrow-slice of less than 7 in. width. On heavy-land leys 8 in. makes the best work; 9 in. is convenient, and 10 in. the limit of good work with an ordinary plough, though 13 in. may be taken with a digging plough; however, for wheat the digging plough is not so well suited to ley ploughing as is the common plough. On fallows for wheat the furrow may be taken as wide as the plough will conveniently turn it. Wheat ploughing is ordinarily performed at a

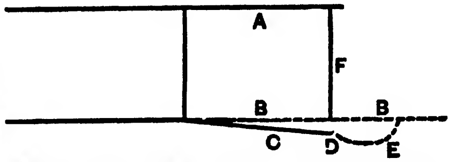


Fig. 1.—Furrow-slice too Deep on the Horse-walk Side

A, Furrow-slice. B B, Line of horizontal horse-walk or sole. C, Share line. D, Edge of share. E, Break out under the already ploughed horse-walk; the tendency being downwards because the line of cut inclines so Failing a clear cut at F on the line B, there is no definite fracture point, and on tough land it may extend some inches, making heavy draught, turning a flat and coarse furrow, coarse and bad ploughing

depth of from 4 to 6 in.; though after roots on light land, where it is desired to leave a firm roothold for the plant, some prefer as little as from 2 to 4 in. Occasionally, late in the autumn, after roots fed off, when working would be difficult, wheat is sown broadcast on the surface and ploughed in, the furrow not exceeding 1½ in. in depth. In this case the furrow-slice is laid flat, and no harrowing is done, the seed being already well covered. We have seen excellent crops obtained thus, when other methods would have been most unsatisfactory. For autumn fallows

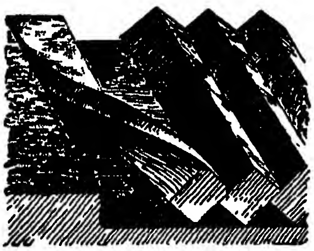


Fig 2.—Rectangular Furrow, unbroken

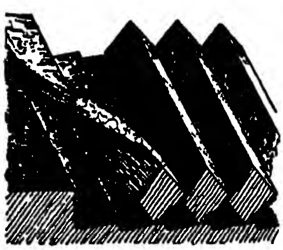


Fig. 3.—Crested Furrow, unbroken

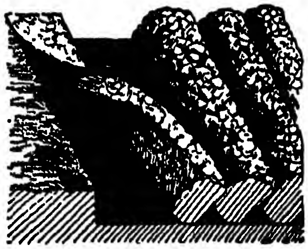


Fig 4.—Rectangular Furrow, broken

to lie through winter, a furrow from 10 to 12 in. width to 6 or 8 in. depth may be taken with the common plough, and 13 in. with the digging plough. When using the digging plough for this work there is no need to make the furrow-slice fall too far over. Cross-ploughing in the spring will be effective on these big furrows. It has to be remembered that a big furrow-slice is not necessarily a coarse furrow-slice. A well-proportioned furrow-slice is not coarse; but if the plough is so set that the share cuts much deeper on the breast side than on the land side, especially if on heavy or tough land, the wing of the share does not shear off the under side level just to the width of the unploughed land, but breaks up several inches in depth and width under the horse walk; this makes coarse work, and it adds very excessively to the draught, for the tearing out is far more difficult than the shearing off, which comes naturally when the share runs horizontally. The easiest furrow-slice to turn is that where the land side of the furrow is deeper than the share, for then the fracture at the wing of the share is helped by the slight edge previously cut; in other words, it splits away easily.

The furrows ordinarily ploughed are rectangular, considerably wider than deep, but they

sometimes take a trapezoidal form (as when the land side is deeper than the furrow side) to present a higher crest than is given by rhomboidal form; the trapezoidal form is also taken when the dip is in the opposite direction, that is, deeper on the furrow side. With digging ploughs, where the shin of the breast inclines towards the land side a right-angled furrow is not obtained, but the opposite sides are parallel. The common plough makes a furrow-slice similar in shape to the section cut, but the digging plough makes a broken-backed furrow-slice in which the shape is kept only when the land is exceedingly tough. A broken-backed furrow-slice is also made by the Kentish plough. Ordinarily the best work is done when the sole of the furrow as cut by the share is horizontal, and the share cuts clean out without leaving any uneven edge.

The methods of setting out the land for ploughing are simple, and are devised for two main reasons — on light land to provide the most economical conditions of turning, and on heavy land to provide what is regarded as the most suitable frequency of water furrows to free the surface from excessive wet. In the former case the water is got rid of by percolation. In the latter, where it is desired to leave the land crowned or raised, this is maintained by ploughing the furrow-slices towards the top or crown five times to ploughing them away four times, as this generally balances the tendency of the

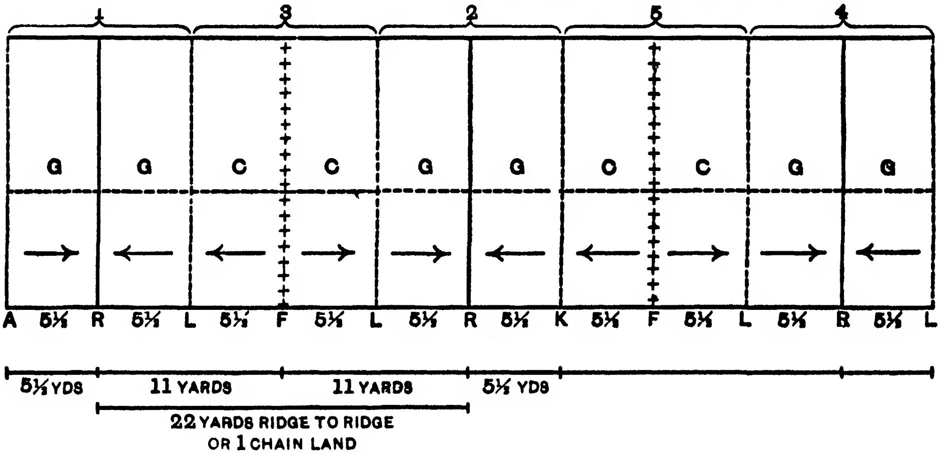


Fig. 5.—Method of Setting out Ridges on Light Land

R, Ridges 22 yd apart. The first is set a quarter of a land, 5½ yd, from A outside of field. F, Finishes or last furrows midway between R R G G, Each quarter land of 5½ yd, *gathered*, that is, with furrows turned whilst the horses as they reach the ends are turned to the right. C C, Each quarter land of 5½ yd., *cast*, that is, with furrows turned whilst the horses as they reach the ends are turned to the left. L, Points at which the castings begin Bracket 1 of 11 yd. is first ploughed. Then bracket 2 of 11 yd. about the second R is ploughed. Both these are gathered. Bracket 3 is the first casting and occupies 11 yd. When this is ploughed, an open space of two furrows from which the soil is turned is left If a special form of finish is required, it is done There are thus 2 brackets of gathering done at this stage and 1 bracket of casting, making 33 yd. from A to K A third ridge has then to be set in the middle of bracket 4 When this is gathered bracket 5 is cast, and so on Arrows show direction in which the furrows are turned On heavy land with high back ridges each land is ploughed as it stands, the lands being all cast or all gathered, with setting at the top or bottom accordingly.

soil to be harrowed or washed by rain to a lower level. In turn-wrest ploughs all furrow-slices are turned in one direction, and no open furrow is left throughout the field.

On light land 22 yd. is almost invariably regarded as a 'land', or that space between two open furrows. To set out the lands it is best first to mark out the width of the headlands or end pieces on which the plough will be turned, and which will subsequently be ploughed at right angles to the rest of the field; custom, according to district, dictates from 5 yd. to 6 yd. as the width of the headland or head ridge. In some districts a headland is provided on all sides, so that the ploughing may be done right round the field, instead of with a ridge placed in the middle of the headland. On the whole this is preferable in many cases, though sometimes inconvenient. Along the lines at the end of the field a stake should be set up at every 22 yd.; but for reasons to be explained the first stake should be 5½ yd. from the side boundary. Feering, ridge setting, or drawing, is the opening up of the land when starting a new ridge or land; and is usually meant particularly to indicate the first draught up a field. It is a shallow furrow-slice leaving the first furrow. It has an advantage that the ridges are not set so high as when two large and thick furrow-slices are brought together. In the best English ploughing matches a feering or false furrow is not permitted, as it is held that a good ploughman should not need the assistance of a shoulder track from which he can easily obliterate crookedness; and also that he should have skill to lay his furrows perfectly and still cover in growth. This is one of the most severe tests in high-class ploughing. When starting, the ploughman sets in his plough against the first stake with the view of going straight to the corresponding one at the end of the field. He may have set up middle marks or feering poles

exactly in line between these to guide him, or if skilled may pick up with his eye sundry guiding marks to lead him. In setting off he starts with his coulter against the stake if he is going to make a split-ridge setting; and the big wheel if he is going to make a simple setting, which will leave an unploughed furrow below that where he turns the first furrow-slices. On reaching the farther end of the field he turns his plough to come back. If he is making a split-ridge, setting his coulter will return down the same track, and the furrow will be thrown in the opposite direction to the first, leaving an open space (ploughed) two furrows wide. On getting back to the other end of the field he will turn back the last furrow-slice ploughed, but will also bring up fresh ground

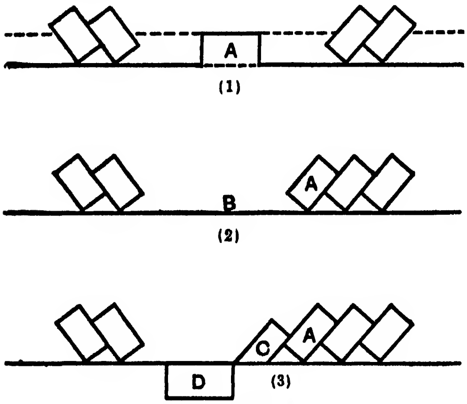


Fig 6.—Finishes

(1) Last furrow, A, still to be ploughed. (2) Last furrow-slice, A, ploughed, leaving furrow. B, 2 horse-walks wide Furrow back finishes are made by simply ploughing one or more furrows back into the horse-walk, B. (3) Mould-furrow finish. The furrow C is a subsoil furrow ploughed out of D. The open space is therefore only one horse-walk wide, instead of two as in (2).

from below, and on reaching the other end will turn back the first furrow-slice similarly. To avoid too high a ridge he ploughs the fresh furrows rather more shallow than he will the remainder of the land. This, however, is often avoided by having the furrow-slices thrown back on to the unploughed land with a fork. When, having ploughed the first furrow in the simple setting, he turns to plough the second furrow, he will run his plough so that the two furrow-slices lie up to one another, or one over the other, as circumstances order. If either of these settings be adopted, the subsequent procedure is similar: he will plough towards the ridge 5½ yd. on either side, making 11 yd. in all; this is called gathering, ridging, &c., according to vernacular. He will then leave this land, and set a fresh ridge 22 yd. from the first, in the same manner as the first, again ploughing 11 yd. This will leave 11 yd. between the two unploughed; and he will then commence to cast or split this by turning his horses at each end to the left, instead of to the right as he has done previously, and continue to do so until he ploughs all.

He now has to decide on the method of finishing. He may leave an open finish, that is, simply leave off when all the land is ploughed, leaving a horse walk two furrows wide; or he may make a mould-furrow finish, which he does by ploughing a furrow out of the subsoil. It is generally best to do this by ploughing a furrow to the other end of the field on another land, and then returning and turning the mould furrow in the same direction as the last ordinary furrow was turned, as he will be able to set his wheels more easily, and will get a better coulter track.

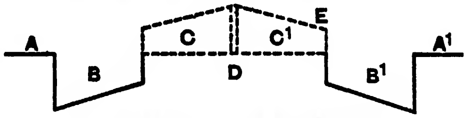


Fig. 7.—Section of Simple Ridge Setting

A, Surface of land B, Horse-walk from which C furrow was cut. D, Unploughed land The plough is generally set deepest on the little wheel side, and a square furrow is not cut, and it breaks away at the other edge. The setting is generally shallower than it will be for the main ploughing, as are the next furrow or two, so as not to give too high a crest to the ridge. On returning the coulter, which in the illustration is along the line E, is often run closer to the first furrow, and then C′ overlaps C more than is shown. It is a rule in many ploughing matches that every furrow must be shown clearly, but in practice this is not so much insisted upon

Sometimes the last furrow-slice and sometimes the two last are ploughed back, in which case no mould furrow would be ploughed. This is called the furrow-back finish, and provides that the horse track is well filled with soil, and so there is no waste portion without soil. Unless there is a special reason of requiring the mould furrow to act as a water furrow to carry off water, the mould furrow has greatly lost its vogue since reaping machines have come into general use.

When ploughing land lying in high ridge and

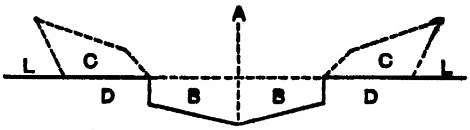


Fig. 8.—Section of Split Ridge Setting.

L, Surface of land. A, Coulter line both up and down, the first furrows being thrown in opposite directions. B, Horse-walks made, the furrow-slices being thrown to C, Turned-back furrow. These furrows are sometimes thrown well back with a fork when a low-crested ridge is desired; otherwise they are turned back to be along with a furrow cut below them at D, which sets the ridge, and ploughing goes on afterwards in the usual manner.

furrow on heavy soils, each ridge is ploughed separately; and it is either ridged or gathered by first setting a ridge and turning the furrows on either side towards the ridge, or it is cast or split by setting a ridge in the bottom on either side and turning all the furrows downhill, thus tending to lower the ridge. When ploughing these ridges in autumn it should be contrived by previous ploughings that the land is ridged to have a water furrow at the bottom to carry off winter rain. If gathered in spring there is less likelihood of rain doing injury.

The following table shows that the rate of

travel of farm horses at plough is slow, taking them to be out of a stable eight hours. On lands 22 yd. wide and 220 yd. long, the average extra walk beyond that actually ploughed due to turning is 16½ yd.

Width of Furrow Slice.	Single-Furrow Turn-wrest Plough.	Swing and 1-Wheel Ploughs.	2-Wheel and Steerage Ploughs.	2-Furrow Steerage Ploughs	2-Furrow Steerage Ploughs.
Width in inches.	Miles in an acre.	Miles in an acre.	Miles in an acre.	Miles in an acre.	Miles in an acre.
8	13	$13\frac{3}{4}$	$13\frac{1}{4}$	$6\frac{5}{8}$	$3\frac{5}{8}$
9	$11\frac{1}{2}$	$12\frac{1}{4}$	$11\frac{3}{8}$	$5\frac{7}{8}$	$3\frac{7}{8}$
10	$9\frac{1}{8}$	11	$10\frac{5}{8}$	$5\frac{4}{13}$	$3\frac{1}{2}$
12	$8\frac{1}{2}$	$9\frac{1}{4}$	$8\frac{7}{8}$	$4\frac{7}{16}$	3

This also shows the advantage of multiple ploughs. [W. J. M.]

Ploughland (or in Scotland **Ploughgate of Land**) is an old measure of land denoting the amount which can be ploughed in a year by one plough. In England the word is equivalent to a hide of land, which according to some authorities was 60 ac., to others 80, and to others 100 ac. It is probable that there was no fixed standard, and that local usage determined the extent. In Scotland the ploughgate of land contained 8 oxgang, each oxgang containing from 8 to 14 ac. Scots according to the nature of the land. Usually, however, the oxgang contained 13 ac., so that the ploughgate of land in Scotland may be taken as the equivalent of 104 ac. Scots, which for practical purposes is equal to 130 imperial acres. Under the Act of 1621, which is still in force, the qualification which entitles a person to kill game in Scotland is the ownership of a ploughgate of land. See under GAME LAWS. [D. B.]

Plover.—The name Plover is loosely applied to the members of several different genera of the family Charadriidæ. The most typical representatives of the plovers in this country are the Golden Plover (*Charadrius pluvialis*) and the Grey Plover (*Squatarola Helvetica*). The Golden Plover is best known on its migrations and during the winter months, when it is numerous on the coasts. It nests in Devonshire and Wales, and in the north of England and Scotland with increasing abundance as one goes farther north. There is a general movement southward in the autumn, and a return movement in the spring. In spring and summer the male has the under parts black, but they become white at the autumnal moult. The Grey Plover greatly resembles the Golden Plover in appearance. It is less numerous, though many flocks frequent the seashore during the winter. The commonest plover in the British Isles, the Green Plover or Lapwing (*Vanellus vulgaris*), which is resident and widely distributed, is described in the art. LAPWING. A common bird on flat parts of the coast is the Ringed Plover (*Ægialitis hiaticola*), which is also resident throughout the year. The Kentish Plover (*Ægialitis cantiana*) arrives on the English shores in April and departs again in the autumn. The Dotterel (*Eudromias morinellus*) and a number of other British birds are also occasionally called plovers. The food of plovers consists of worms, slugs, small mollusca, marine insects, &c. [H. S. R. E.]

Plum.—Plums are the hardiest of all stone fruits. They will succeed in any moderately good soil with but little attention, and their remarkable cropping powers make them of exceptional value for cultivation for home use. This same prolificacy is, however, somewhat of a drawback to the market grower. In seasons of an abundant crop prices are so low as not to be profitable, and there would be a glut of plums every year were it not that the blossoms are liable to be damaged by spring frosts—a contingency which renders it advisable to grow a variety of sorts. It is the grower upon high-lying land but little visited by late frosts, and who thus has a crop when his competitors have not, who makes the most money by growing plums. Even when sold at a very low price, £80 per acre may be realized from a crop of plums.

Plums are best suited by a good loamy soil containing lime, one which is neither too wet nor too dry. Excessive dryness is very damaging to stone fruits; the soil should therefore be deeply worked, and mulched in summertime, or kept in good surface cultivation by hoeing. Plums root near the surface, and the ground must therefore be dug once a year, failing which it should only be hoed. It is usual to plant standards and half-standards 20 ft. apart, with from 20 ft. to 25 ft. between the rows, and small pyramid and bush trees from 6 ft. to 9 ft. apart. Plums may be advantageously grown on espaliers, in which case not less than 12 ft. should be allowed between the rows. Extra choice varieties are commonly planted upon walls with an eastern or western aspect, but where wall space is limited we should prefer to devote it to more tender fruits. The pruning of plums is not difficult. The main branches of standards do not require to be shortened back in the winter, except those which have made over-luxuriant growth; but branches which cross may be entirely removed, and the numerous small side shoots cut back to the fifth bud, which will assist in the production of fruit. Suckers springing from the roots should be promptly removed. Trees planted in rich soil are liable to make too much growth; this is best counteracted by lifting and replanting or by root-pruning in autumn. Trees on walls are generally grown in the form of a fan. Plums are generally propagated by budding or grafting. In budding, care must be taken that wood and not fruit buds are used, and in grafting that there are wood buds on the scion. When stocks are raised from stones the young plants should be cut down to two buds a year after transplanting from the seedbed. The fruit crop is often so heavy that it would break many of the branches; this is best prevented by thinning when the fruits are still quite hard and green, in which state they are valuable for culinary purposes. Choice dessert plums should be allowed to become fully ripe on the trees unless it is desired to keep them for a time, which may be done by wrapping them in paper and storing them in a dry airy place, but plums which have to travel should be sent off before

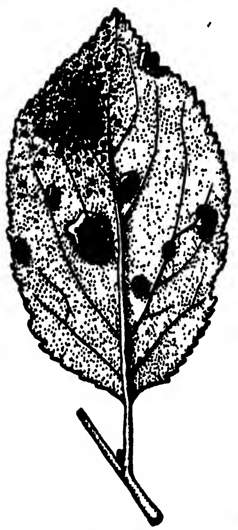
they are fully ripe. Dessert plums are grown under glass in the most complete gardens, usually in pots or tubs. They will stand but little forcing, and require roomy, airy, and light glass-houses. The Gage sorts are favourites for growing in this way. These are not so hardy as other plums, and the true Greengage is only cultivated in one district of Cambridgeshire on a large commercial scale. Damsons are valuable by reason of their thriving with next to no attention, and as they usually sell well, they make a very profitable hedge. Bullaces are generally considered as quite inferior, but some people are partial to their peculiar acid taste. The chief enemies of plums are the Apple Mussel Scale; various aphides and Red Spider; the Small Ermine and Winter Moths; stem-boring weevils; birds, which eat the fruit buds, and wasps, which eat the fruits. Heavy syringings are usually necessary to destroy the aphides, which are particularly partial to plums.

There are a great number of good sorts of plum, and of these it is only necessary to mention Angelina Burdett, Bryanston Gage, Coe's Golden Drop, Early Transparent, Guthrie's Late Green, and Greengage as being first-rate dessert sorts; and Rivers' Early Prolific, Victoria, Magnum Bonum, Grand Duke, Rivers' Late, and Coe's Late Red as being a good selection for general purposes, their ripening extending over a long season. [W. W.]

Plum.—Parasitic Fungi.—

Leaf-destroying Fungi.—The foliage of Plum, Blackthorn or Sloe, and Bullace may be damaged by fungi as well as insects. *Rust* appears chiefly on the under side of the leaves either as specks of light-brown powder (the uredospores) or somewhat later in the season as a darker brown dust (the teleutospores) of a rust fungus *Puccinia pruni*; no æcidium stage is known. *Leaf Blotch* is less common, and is recognized by the red swollen patches on the leaves; these result from an Ascomycete fungus (*Polystigma rubrum*) which gives off summer sporules from tiny openings on the red patches, and forms winter-fruits on the fallen dead leaves, whence arise ascospores ready to infect young leaves in spring. *Powdery Mildew*, so frequent on different fruit trees, forms a whitish mould during summer and winter-fruits on the fallen leaves (see Apple—Parasitic Fungi). Several fungi cause dry spots or 'shot-holes', and so damage the leaves that the fruit ripens badly, while the young wood is not matured and dies off during the winter.

Treatment.—Since in all the above diseases the leaves carrying the fungus fall to the ground, it follows that careful raking up and burning of these will do much to prevent future attacks. Spray fluids will check the summer stages; the first spraying when the buds begin to swell is done with Bordeaux mixture of medium strength (see Fungicides), the second follows after the petals drop. If later spraying is necessary, cupram or potassium sulphide (½ oz. to 1 gal. water) is preferable, as neither stains the green fruit; the coloured fruit should not be sprayed.



Leaf of Plum, with large swollen spots bearing *Polystigma rubrum*, and at the apex small brown patches of Rust Fungus (*Puccinia pruni*). [From Tubeuf.]

Fruit Rot.—If this appears on ripe or nearly ripe fruit it probably results from insects, or bruising of the fruit. If it occurs on young fruits it is generally due to *Monilia fructigena*, common on other fruits (see Cherry — Parasitic Fungi). A disease known as 'pocket plums' or 'bladder plums' is easily recognized; soon after flowering the fruits swell up and become elongated, wrinkled, dry plums with no stone; the fungus-filaments live in the twigs, and the disease is difficult to combat except by hard pruning and by collecting and burning the 'pocket plums'; the fungus is common on the wild Bird Cherry, and this may serve as a source of infection.

Wood Rot and Gummosis. Consult arts. on Apple—Parasitic Fungi, Cherry—Parasitic Fungi, and Gumming. [W. G. S.]

Plum, Insect Enemies of.—The chief pests attacking plums are: *Scolytus rugulosus* (Bark Beetle), *Xyleborus dispar* (Shot-hole Borer), *Diloba cæruleocephala* (Figure-of-8 Moth), *Aspidiotus ostreæformis* (Oyster-shell Bark Louse), *Aphis pruni* (Leaf-curling Plum Aphis), *Hyalopterus pruni* (Mealy Plum Aphis), *Chlorita viridula*, *Typhlocyba quercus* (Leaf-hoppers), *Antithesia pruniana* (Plum-leaf Tortrix), *Cladius padi* (Plum-leaf Sawfly). All these insects are described under their technical designations except *Hyalopterus pruni*, which is described in the art. Mealy Plum Aphis.